THE ENGINEER

A Seven-Day Journal

The New Town Development Corporations' Reports

UNDER the New Towns Act, 1946, the various Development Corporations are required to submit to the Minister of Housing and Local Government annual reports of progress. There has just been published by H.M. Stationery Office a Blue book (price 10s.) containing the reports for the year ended March 31, 1951, of the Aycliffe, Basildon, Bracknell, Corby, Crawley, Cwmbran, Harlow, Hemel Hempstead, Peterlee, Stevenage, Welwyn Garden City, and Hatfield Development Corporations. The reports summarise the work done during the year in planning, land acquisition, the provision of public services and, in those instances where building has been going on for some time, the progress of the various contracts which are being carried out under the Corporation's direction. As an example, the Crawley Development Corporation states that there have been completed and handed over the first two blocks of standard factories, comprising 33,800 square feet. They have been let to six firms, all of which are now in production. The remaining factories included in the Corporation's first industrial programme amount to a further 57,600 square feet. All of them have been let and are now being completed. At Harlow the main contracts let by the Corporation during the year reviewed amounted to £3,163,439. The contracts included 7·7 miles of estate roads, 2·4 miles of main roads, and 5·3 miles of branch sewers. About industry, the Harlow Corporation says that there is still a gap between the building of houses and the provision of factories, but by the end of the year negotiations were virtually complete for 204,000 square feet of factory space, all of which, except for 60,000 square feet, is being built by the Corporation. But, the Corporation adds, "the most serious shortage is in steel, which is needed for factories, roads and sewers." Some of the other corporations comment on the problem of balancing housing and employment, and on the difficulties of obtaining sufficient labour as well as materials for proceeding with the projects specified in their various master plans.

Institution of Water Engineers

THE winter meeting of the Institution of Water Engineers was held on Friday last, December 7th, when three papers were presented for discussion, the meeting being held at the Institution of Civil Engineers. A paper entitled "Some Problems Concerning Distribution of Water" was presented by members of the research group of the Institution. It was concerned with investigations of current and new practice in plumbing for water supplies, and included notes on producing a lead pipe at a competitive market price by using a thin-walled lead tube strengthened by an outside wrapping. Pipe couplings were also investigated, as were alternative methods of protecting storage tanks from rust, and the use of plastic materials for tanks and for tubing. A second paper entitled "Prestressed Concrete Pipes" was read by G. A. P. Ooykaas, and consisted of a review of preliminary studies for a 30-mile pipe-line project at Amsterdam. Various sorts of prestressed concrete pipes and their methods of manufacture were described, and a method for the static calculation of the pipe wall was given. Mr. T. S. R. Winter presented a paper entitled "The Low Worsall to Wilton Raw Water Supply," which described those parts of the Low Worsall scheme, which he considered to be of special interest. The idea of the scheme was to abstract 6 m.g.d. of raw water from the River Tees at Low Worsall and delivering it to the new Wilton factory of Imperial Chemical Industries, Ltd. A pumping station and 27in diameter pipe-lines, some 13½ miles in length, were built, the water being delivered into an open service reservoir of 6 m.g. capacity. An interesting point about the paper was the analysis given of the bearing pressures of the cast-in-situ piles employed and of the earth pressures resisted by the steel sheet piling retaining the southern bank of the Tees and forming a cofferdam.

The Royal Naval Scientific Service

THE Admiralty has announced the promotion to the rank of Chief Scientific Officer in the R.N. Scientific Service of Mr. John Anderson, M.I.E.E., chief scientist at the Admiralty Signal and Radar Establishment, Haslemere; Colonel A. V. Kerrison, director of aeronautical and engineering research, Admiralty; and Dr. E. C. S. Megan, director of physical research, Admiralty. Mr. Anderson was educated at Spiers School, Beith, and the Royal Technical College, Glasgow. After two years' post-graduate training in the Rugby works of the British Thomson-Houston Company, Ltd., he joined the Admiralty Experimental Station at Parkeston Quay as an assistant physicist. Prior to his appointment as chief scientist at the Admiralty Signal and Radar Establishment, Mr. Anderson was chief scientist at the Admiralty's Underwater Detection Establishment. He was awarded the C.B.E. last year. Colonel Kerrison has made a particular study of gunnery problems and was responsible for initiating systematic research in the development of gunnery fire control. Dr. Megan spent two years as a Beit scientific research fellow under Professor C. L. Fortescue at the Imperial College of Science and Technology, and later joined the research laboratories of the General Electric Company, Ltd., where he remained for sixteen years under the direction of the late Sir Clifford Paterson. During the war Dr. Megan led a team which made significant contributions to magnetron development, and he was also responsible for the General Electric Company's part in the wartime studies of centimetric wave propagation. He joined the Admiralty in 1946 as superintending scientist at the Admiralty Signal Establishment's radar extension.

Safety of Life at Sea

THE Ministry of Transport has announced that the International Convention for the Safety of Life at Sea, which was drawn up at the International Conference held in London in 1948, will come into operation on November 19, 1952, and replace the convention which was drawn up in London in 1929. The conference was attended by delegates from thirty countries, and the convention which they prepared provided that it should come into force one year after fifteen countries—seven of which had not less than 1 million gross tons of shipping—had deposited their acceptances with the Government of the United Kingdom; the fifteenth acceptance was deposited on November 19th last. In consultation with the representatives of the owners, officers and men, the Ministry of Transport are now engaged in drafting the regulations and rules which will be required to give effect to the provisions of the new convention, the necessary powers having been taken in the Merchant Shipping (Safety Convention) Act, 1949. The International Conference on Safety of Life at Sea, 1948, generally confirmed the standards of construction of passenger ships that were laid down in the safety convention of 1929, but it lays down much more comprehensive requirements in regard to fire protection and fire-fighting equipment and rules for fire detection and extinction on cargo ships of over 1000 gross tons as well as for passenger ships. Requirements to preserve the stability of passenger ships in damaged condition are included, and cargo ships, as well as passenger ships, are required to be inclined to provide masters with stability information. Provisions with regard to the electrical installations in passenger ships safeguard the essential services in an emergency and protect passengers and crew against electrical hazards. In future, the requirements regarding life-saving appliances will apply in future not only to passenger ships, but to all cargo ships of 500 gross tons and upwards, which will be inspected every two years and furnished with a safety equipment certificate covering not only the life-saving appliances, but also fire appliances and lights. Ships in special trades not provided with lifeboats for all on board will have to comply with special subdivision requirements. The use of radial davits in new ships, and life-rafts in lieu of lifeboats, is to be discontinued, and every ship will have to carry a lifeboat or lifeboats fitted with radio or provide portable radio for use in the lifeboats. All passenger ships and cargo ships over 1600 gross tons will have to carry at least one motor boat or mechanically hand-propelled lifeboat. The new convention provides that a continuous radio watch on the distress frequency, either by an operator or by auto-alarm, shall be maintained by all ships over 1600 gross tons, which will have also to carry direction-finding apparatus, and all cargo ships of between 500 and 1600 gross tons will be required to be fitted either with wireless telegraphy or wireless telephony. The convention also provides regulations regarding the carriage of grain, and sets out certain broad principles which will govern the carriage of dangerous goods on board ship.

Ways of Preventing River Pollution

MR. HAROLD MACMILLAN, Minister of Housing and Local Government, has sent a circular to all river boards and local authorities giving advice on the exercise of powers which now exist for preventing river pollution. The circular explains that the Rivers (Prevention of Pollution) Act, 1951, now makes it possible for river boards to safeguard the quality of rivers which are not already polluted and to secure gradual, but distinct, improvements to those streams, particularly in industrial areas, which receive large volumes of trade wastes. For the first time local authorities, industry and traders can be provided, under the procedure laid down in the Act, with clear and precise information about the conditions which must be satisfied when effluents are discharged into streams. In the circular, the Minister expresses the hope that improvements can be made while interfering as little as possible with the nation's industrial economy. He recommends close personal contacts between river authorities and those local authorities and industrialists who are preparing schemes which will necessitate new discharges into rivers. In this way proper measures for treating effluents can be adopted at an early stage, so that costly recasting of plans can be avoided. It is considered too early to give advice on the drafting of standards needed to ensure that effluents are acceptable, but the production of a document embodying conclusions reached is promised at a later stage. The powers under the Act will be exercised by the Thames Conservators, the Lee Conservancy Catchment Board, the Metropolitan Borough Councils, and the river boards set up under the 1948 Act.

The End of an Era

BY EDWARD H. LIVESAY

No. V—(*Continued from page 717, December 7th*)

"TRAIN No. 1" left Revelstoke for Vancouver at 8.42 a.m., headed by "Pacific" No. 2388, and with myself in the train. I intended to join the engine at Sicamous, 44 miles west, meanwhile doing a little observing from a reclining chair through the coach window—if I happened to wake up. I have mentioned the comfort of modern railway cars in Canada, and what an improvement they are on the rolling stock of pre-war days. Fig. 27 shows the reclining chair in a day coach, and brings out how the backs can be adjusted to any angle from the upright position seen at the left to a reclining one on the right. The former is the usual position for day use and the latter at night, or whenever the occupants want to stretch out. The foot-rests as well as the backs can be adjusted at will, and altogether the cars are very comfortable, quiet and smooth-running; one hears nothing but a soothing muffled rumble. So far as my experience went on these Vancouver-Calgary runs, the air conditioning was well regulated; only once was a car overheated—at Spence's Bridge, where we were stuck for several hours while a wash-out was repaired.

Gone is the clumsy, massive construction and florid decoration of the old cars; the windows that would not open or, if by chance they did open, would not shut. The windows are sealed and the cars air-conditioned, and that's that. Every coach has a smoking section at one end, separated from the non-smoking part by the door seen in Fig. 5, The decorative scheme is quiet, cool grey-silver-chromium with light blue and white here and there.

The lighting is good, and I was particularly struck by the quietness and smoothness of the running, though only four-wheel trucks are fitted, and the cars are much lighter than the old patterns, 59 tons (52¼ short, English). They are 84ft 6in long over buffers, 78ft long inside and about 10ft wide, seating fifty-two in the main part and sixteen in the smoker. The reader will now easily understand why I sometimes found it such a relief to vacate the cab and "recline" in a coach. A coach, by the way, is the equivalent of a third-class non-sleeping car in Britain. Coaches are always put in the front part of a train, next to the baggage car. In passing, the clerestory roof has gone the way of a lot of other old details; roofs are now always elliptical.

As I never had occasion to use a sleeper during these runs, I ought not to say anything about them, these articles being nothing if not a record of actual experience. Either I stopped off at night, or so much of it was spent in the cab that it was useless taking a berth; a "reclining chair" made a good enough substitute. I might just mention, however, that sleepers vary in comfort and convenience from a "Roomette," an individual compartment with toilet fittings, the bed disappearing into the wall for day occupancy, down to a "Tourist" sleeper with the old upper and lower berths, comfortable enough when you are in them, but necessitating undressing in one's berth, a diabolical gymnastic feat, so exasperating and temper-trying, I am convinced it is the cause of half the crime in Canada. The latest sleepers run on six-wheel trucks, are 75ft 6in long and weigh 80 tons (British).

FIG. 25—ROYAL HUDSON CLASS C.P.R.

Diners do come into the picture; I use them sometimes when my duties in the cab permit and I am not too filthy for decent surroundings, though this is seldom the case in B.C., thanks to oil fuel. I consider the catering in Canadian diners admirable—if one is willing to pay the price. Food is good and admirably served; after a long spell in the cab it is delightful to sit down and eat an attractive meal in quiet comfort, and the temptation is one I cannot always resist, dirty or not. The interior of a dining car, exhibits the same *motif* as the coach—quiet, simple, harmonious decoration and fittings. The lighting in a pastel blue ceiling is pleasing, and walnut panelling at the ends adds to the general effect of refinement and good taste. I really cannot complain of anything in a modern Canadian diner—except, of course, the price. But there, I suppose, it is impossible to satisfy everybody.

It was a lovely day, of sunshine and blue sky: the masses of snow piled along the highway adjacent by a plough were shrinking fast, leaving pools of water on the pavement. The Eagle River kept us company here, the line crossing it several times. From Three Valley—a pusher generally helps the train over this peak, but did not on this occasion—the gradient falls steadily westward and once the Taft-Three Valley bank is left behind the drop is fairly easy, only 340ft in 45 miles. Beyond Craigellachie, where the "last spike" was driven in 1885, the valley widens and small farms appear instead of endless rock and torrent. Sicamous and a ten-minute stop, coincident with the end of Shuswap Lake, gave me a chance to get to the engine and become acquainted with it and Enginemen Fraser and Olund. The track is almost a "water-level" one here, following the shore of Shuswap Lake and Salmon Arm for several miles, and the speed rose to a respectable 45 m.p.h., but curvature is incessant and there is a limitation in force—probably this figure—in the interest of safety. The riding was noted: "not bad, but might have been better." Fraser mentioned tight wedges and complained of the way the shop people would overdo wedge adjustment, apparently with the idea of putting the evil day when this would again become necessary as far into the future as possible. It always seems to me that the American system of equalising the springs, with its numerous pins and links, is chiefly the result of custom—they always have done it and keep on doing it, whether necessary or not, and it may be sometimes of doubtful value. When it is first set up and carefully adjusted no doubt it does act well, giving easy riding and good weight distribution, but when the pins begin to wear and partially jam, the weight distribution is progressively upset until it may become altogether different from what was intended—heavy on one axle

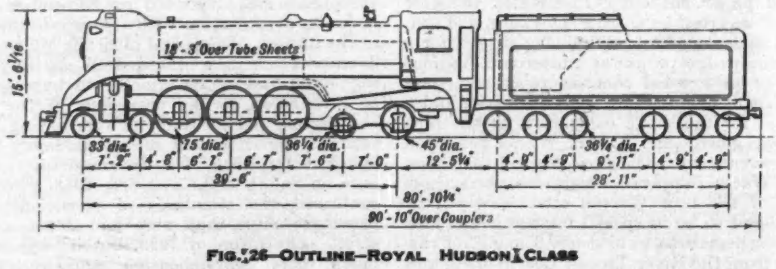


FIG. 26—OUTLINE—ROYAL HUDSON CLASS

and light on another. After riding large numbers of both British and American locomotives over all sorts of track I am convinced that equalisation is not necessary at all where the road-bed is reasonably good.

No assistance was needed on the Notch Hill incline either, the load only being nine cars, say, 600 tons, well within the capacity of a 46,000 lb T.E. engine, even minus a booster. Monte Creek showed far less snow lying; we were getting into the "dry belt," (Fig. 29), following the S. Thompson River, which has its birth in Shuswap Lake. The speed was higher, often over 50 m.p.h., and Olund and I improved the shining hour with a little timing, clocking several miles in sixty-seven seconds or thereabouts, at which I had to confess the riding was not good, but this may have been due to the track—frost coming out of the road-bed after winter's onslaught. Nearing Kamloops, I noted: "Doing about sixty—riding very rough—no doubt about it," and I was not sorry to stop off at this Divisional point: the bucketing of No. 2388 was beginning to get on my nerves. In any case, I wanted to cover the rest of the way to the coast on a "2800" class "Hudson," to complete my observations of all three types operating at the end of the era between Vancouver and Calgary. I shall certainly never have another chance.

FIG. 27—RECLINING CHAIR IN COACH

FIG. 28—DINING CAR

Kamloops marks the end of the second Division out of Vancouver and the westbound "Dominion" is timed to leave at 11.50 p.m.: actually it pulled out at 12.40 a.m., headed by engine No. 2862, "Royal* Hudson," "HIe" class (Figs. 25 and 26), one of the final group of five built in 1940. There are sixty-five of these very fine engines, numbered 2800–2864; the first came out in 1929, and they work all the finest trains right through from Montreal to Vancouver, 2882 miles, with the exception of the 262-mile mountain section, Revelstoke to Calgary. Save for the half-dozen or so that came to Vancouver in the early 'forties to take the place of the demoded 2700 "Pacifics," the class were all coal-burners until, recently, the engines operating between Winnipeg and Calgary were converted to burn oil. I daresay all prairie locomotives will be converted, too, in the future: coal is a nuisance, from the raising up thereof out of the ground until its going back in ashes. Bulky, dirty, smoky and hard to handle—this applying to the people who dig it as well—no wonder oil is steadily taking its place wherever supplies are available at a reasonable price, as they certainly are on the prairie. Limitless quantities, apparently, underlie great areas of the West and North West, making the demise of coal as a fuel more than probable. The end of another era!

The chief dimensions of the "Royal Hudsons" are as follows:—

Cylinders	22in by 30in
Steam pressure	275 lb
Driving wheels	75in
Tractive effort	45,390 lb
Booster	12,000 lb
Grate area	80·8 square feet
Weight on drivers	81 tons
Weight of engine	153 tons
Weight of tender	118 tons
Weight, total	271 tons
Heating surface:	
Tubes and flues	3465 square feet
Firebox	288 square feet
Arch tubes	38 square feet
Superheater	1542 square feet
Total	5333 square feet
Distance between tube plates	18ft 2in
Water	12,000 Imperial gallons
Oil	4,100 Imperial gallons

An "Elesco" feed water heater is used and a Hancock exhaust steam injector. A multiple throttle and screw/air reverse are fitted, and the engine and trailer truck axles have roller bearings. No dome is used, only a dry pipe and steam drier—Walschaert valve gear, of course. C.P.R. engines are now painted chocolate, black and gold, and look exceedingly well, quite the neatest of any locomotives I know of on the North American Continent.

On this occasion the "Dominion" was running in two sections, ours being the first, and the enginemen were Messrs. Gray and Calvert; the former had been in charge of No. 2390 from N. Bend eastbound a few days before. The load was heavy, but I omitted to get the number of cars—not less than twelve, anyway. The weather was fine, dry and not freezing. With the booster cut in the start gave no trouble, steam was well up, the engine having come through from Revelstoke, and the old crew handed over with everything in good shape. After the turbulent "Pacific" of the day before No. 2862's riding seemed luxurious, and speed rose along the double track that is found for some miles west of Kamloops. There was a full moon, too, which made conditions pleasanter along the very sinuous riverside stretch through the mild coast air, so soothing after the sharper tang that had prevailed during the past week in the mountains. The prevailing gradient was downward, from 1159ft at Kamloops to 493ft at N. Bend, and there are several short tunnels between Tranquille and Savona; at Ashcroft—where the potatoes come from—a stop was made for water, and I migrated to the train for sleep; falling off the seat seemed to render this advisable lest worse betide. I might have remained there, dead to the world of locomotives, had not an amusing thing happened at Gladwyn, some 40 miles farther on, which not only woke me, but probably did the same to every soul in the train, and undoubtedly caused all the passengers to blaspheme—to say nothing of the crew. I was roused by that nerve-wracking, back-breaking shock characteristic of an American train jerked into motion by a powerful engine first giving up all the slack in the couplings by backing, and then going forward into the collar without the slightest regard for passengers or draught gear. Again came the convulsion; again, and yet again, and for fifteen or twenty minutes the shattering concussions went on, until the air was full of execrations and profanity. To these I did not add my quota; I was too full of sympathy for "Dolly" Gray in the trouble that had evidently come upon him to feel any for myself, and was only too thankful I was not in the cab. "What on earth is he doing?" I asked myself; "what is the use of him keeping on trying—he has failed about twenty times—he'll bust a draw-bar in a minute!" But I was wrong; the twenty-first plunge succeeded and the "Dominion" got under way, only to "go into the hole" almost immediately to let a freight train by. At the next stop, Lytton (Fig. 29, shows the C.P.R. on the right and the C.N.R. on the left), all desire for sleep having been shaken out of me, I went forward to the engine. The atmosphere in the cab seemed somewhat strained; nobody was saying anything, and I did not like to risk being the first to break the silence, merely looking at Calvert, who grinned. Suddenly Gray swung round in his seat with a roar of laughter: "Well, Victoria, why don't you say something? Cat got your tongue?" This relieved the tension; I said, "No, I can't think of anything to say—it was beyond words—the passengers are after your blood! What happened?" "Oh, I guess it was my fault," he replied; "I shall be on the carpet all right!" It appeared that when stopping

* "Royal" because No. 2850 hauled the Royal train through Canada in 1939; the whole class bears a crown on the side plate near the smokebox, as will be seen in the picture: an honourable distinction—E. H. L.

FIG. 29—NEAR LYTTON IN DRY BELT

to let the fireman off to open the switch, Gray had misjudged both his distance and the associated gradient, which was adverse, halting too soon, well short of the switch, and with both engine and train still on the incline. The result was that all No. 2862's booster-assisted 57,000 lb of tractive effort had been barely enough to get the "Dominion" going again. It had been a new experience for me, anyway—the very worst get-away it had ever been my lot to undergo, and as such it will stay in my memory. Inquiring why he hadn't gone back to the foot of the gradient and had another smack at it, Gray said: "Because it's several miles long, and the second section of the 'Dominion' is just behind us, and would have had to go back, too; there'd have been more trouble for everyone. The best thing was to try and get the so-and-so to go ahead!" There is a moral in this: it just shows what a little perseverance can do—when you've got a booster to help.

Just beyond Lytton the Thompson and Fraser join and the Canyon begins; shortly afterwards the line crosses the river and turns south, changing sides with the C.N.R. at Cisco; the Fraser is on our left here. It began to get light as we neared N. Bend, which was reached at 6.27 a.m., and Gray and Calvert handed over to Johnson and Danielson for the last lap to Vancouver; we pulled out at 6.40 a.m. Johnson, too, had a story to tell. Running the "Dominion" eastbound—it had passed us some way back—he had been held at China Bar, the next station west of N. Bend while possible trouble ahead was looked for. A rock from high up the mountains had come down and crashed on to the track, damaging one of the rails and bounding on into the Fraser, carrying away some of the telegraph wires in its flight: fortunately, for it was this that gave warning to the track gang of something being amiss. The fault was located before the "Dominion" came along, and repaired before it was allowed to proceed. Almost every crew I travelled with had said how bad conditions had been in the mountains that winter, what with snow and rock slides, washouts and so forth, due to the unusually mild weather—in B.C., mildness, like truth, s relative, depending on where you are; 40 deg. is mild at Victoria, but so is zero at Fort George. Little need be said about this stretch, which was sufficiently dealt with in an earlier article.

At Agazziz all snow had disappeared from beside the line, and it was raining; we had left the winter behind in the mountains, and had passed through the "dry belt" with its scattered jack-pine timber, sage-brush, sumach, and parched red sandy soil. This was the moist coastal area, with its rains and lush vegetation, and I must say I always enjoy sniffing the soft air again after coming through from the east—it is like getting home. Besides, it was a relief, I am sure, to everyone in the cab to realise there were no more rocks and slides to keep a constant watch for; they had been in the minds of all of us when winding along on narrow ledges high above the waters of the Fraser, liable to be bombarded at any moment by foot-loose fragments from the upper levels. That risk was past.

Once down on to the delta, over the flats to Mission, No. 2862 reached 60 m.p.h. in places, and Fireman Danielson and I had a friendly discussion about the speed capacity of the "Hudsons." I guessed what was coming when he asked me what I thought they could do—he was young and very loyal evidently to these engines; actually we were largely in agreement on the subject. I advanced the hypothesis that probably 100 m.p.h. was about their maximum, but that they would not be really happy at anything much over 80. He laughed; "They were built to do 120, and can do it, too!" I gently pointed out that the world's record was only 125, shared between two engines, one British, with 80in drivers, and the other German, with 91½in—someone correct me if I am wrong—and that the "Hudson's" 75in wheels would have to revolve very, very fast to produce 120, at which speed—supposing it were ever reached—the balancing would most likely be hopelessly out, with dire results to both engine and track. My objections did not seem to have much effect: to enthusiasts like my young fireman friend, mechanical impossibilities are mere airy nothings; I failed to convince him. Not that I tried very hard to do so, seeing that he was on home ground where I was a mere visitor; again I suggest, never argue in the cab! I have travelled 80 m.p.h. several times on these "Hudsons" (THE ENGINEER, November 28, 1941), and it struck me then they were getting near their comfortable limit—which was not at all comfortable for me. This was between Montreal and Ottawa, also with the "Dominion," when 106·6 miles were covered one way, with two stops, at an average of 55·6 m.p.h., and the other way, with one stop and a dead slow, at 57·6, both inclusive; the two engines were Nos. 2810 and 2826. At this speed the riding of both engines happened to be very bad, but apparently they wanted shopping, and the finest riding engine in the world will misbehave when in poor condition. I should have mentioned these runs to Danielson, but there—I do not suppose it would have done any good! "A man convinced against his will . . ." It is useless putting facts before a railwayman when he is "talking big" about speed—they simply do not register. And when the railroadman is an American—or a Canadian, for that matter—one is

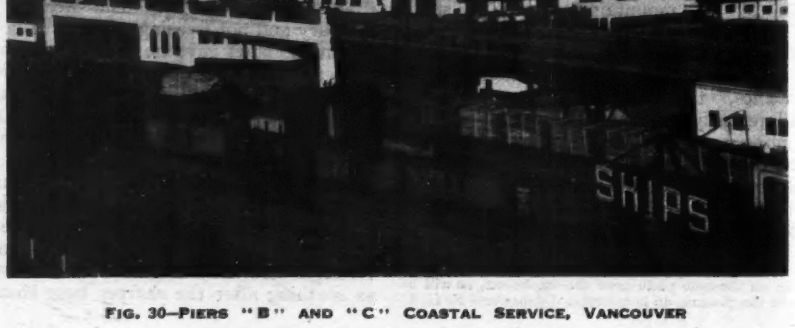


FIG. 30—PIERS "B" AND "C" COASTAL SERVICE, VANCOUVER

apt to be wafted into the realm of the fantastic. But to get back to No. 2862. I do not think anything over 60 m.p.h. was done approaching Vancouver, though perhaps it might have been, had I known early enough, that—according to Johnson—I had only to tell the conductor that I wanted to catch the morning boat to Victoria and orders might have been passed up to the cab to speed up a bit. Johnson said that when there were enough passengers—or when one of them was important enough !—making the passage to Victoria, efforts were generally made to ensure the connection, which, all being well, is simple enough ; The "Dominion" should get in at 8.30 a.m., and the boat shoves off at 9.30 ; it is when "No. 7" is behind time that steps have to be taken. On this occasion the train was heavily loaded, and probably there were a number of passengers for Victoria aboard, to say nothing of a supercargo in the cab, but I did nothing in the matter ; we were running so much behind that it seemed hopeless to try and recover anything worth while, so, like Brer Rabbit, I lay low an' sed nuffin'—there was another boat at midnight anyway. And so things turned out ; we missed it by a wide margin, coming to a stand at 9.53 a.m., and by the time I got outside the station the "Princess Marguerite" was well clear of Pier C (Fig. 30) ; in fact, rounding Brockton Point and about to pass under the Lion's Gate bridge, the towers of which can be seen faintly in the left middle distance of the picture. Thus ended my very interesting 1500-mile excursion, strenuous and with the unexpected always happening, one of the toughest I have ever made, in which every schedule was shot to pieces, not one train arriving on time, due to causes beyond anyone's control, the weather being chiefly responsible. Certainly no discredit can be attached to the engines, all of which had done well ; it had been a most outstanding locomotive experience, full worthy to take its place with the others that have been recorded in THE ENGINEER during recent years.

The three classes of steam locomotive whose work has been described in the account, "Pacific," "Hudson" and "Selkirk," are the last to be designed and built by or for the Canadian Pacific Railway. They will have no successors. So far as Canada is concerned, they represent the culmination of the work of Trevithick and Stephenson begun a century and a half ago. They are descended in a direct line from the Penydarran tramroad engine and the "Rocket," and this article has described the sort of work they did and the environment in which it was done. Soon they will hand over to the diesel-electric, which will probably do the job better—or so we are told, and I will admit it is quite likely. Nevertheless I am sure I shall never be able to feel the same interest in gliding up to Glacier in the luxurious cab of a three-unit diesel as in being suffocated in the Field Spirals on "Selkirk 5921" ! The first will probably bore me—the other never does. Neither shall I feel the same pleasure in recording the diesel's performances ; after all, what is there to record ? The steam locomotive was my first love, and I am still loyal to it, finding it difficult to transfer my affections to its supplanter. It is the end of an era.

I am very much indebted to Mr. Manson, superintendent at Vancouver ; assistant superintendents Hartley and Lewthwaite, at Revelstoke and Field respectively ; Mr. Leo George, assistant superintendent of motive power, Montreal ; to Messrs. Magor and Donovan, of the Public Relations Department, Vancouver, for all the assistance they gave in connection with the journey from Vancouver to Calgary and return, for the facilities extended to me and the data supplied, upon which the whole thing was based ; and to the numerous enginemen and train crews, the roundhouse staffs ; in fact, to everyone concerned, from whom, without exception, I received nothing but courtesy and good-will.

(To be continued)

Hydro-Electric Power in the Isere Catchment of the French Alps

No. IV—THE ARLY AND THE DORON DE BEAUFORT

(Continued from page 719, December 7th)

AT the most northern part of its course some 80km downstream from its source near the Italian frontier, the Isere is joined by the right bank tributary, the Arly. The steelworks at Ugine has used power from the Arly for many years, but Electricité de France has recently constructed a new power station with a considerably larger output than its predecessor.

There are several points of interest in the design of the new works, which consist of a gravity dam at Les Mottets, about 12km upstream from the power station, with a tunnel, including intake works for a subsidiary stream, the Flon, at one point, a surge chamber and a pipe-line down the mountain-

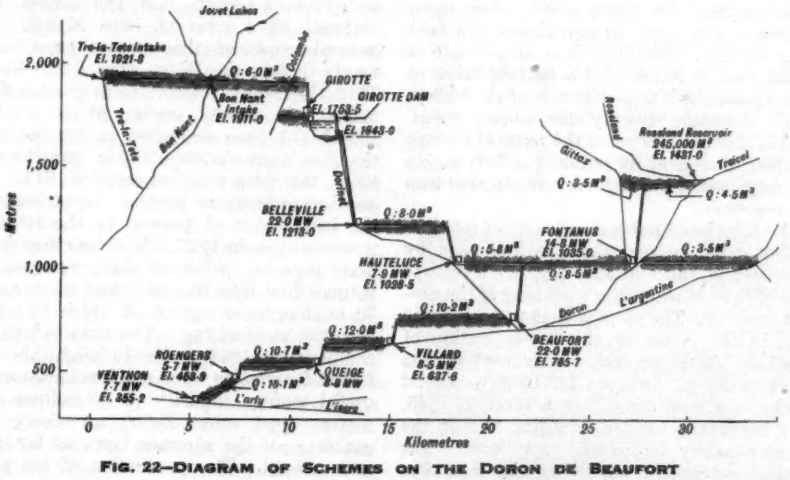


FIG. 22—DIAGRAM OF SCHEMES ON THE DORON DE BEAUFORT

side to the power station. The pipe-line is buried for æsthetic reasons and so that the land under which it passes can be cultivated. The gross head is about 380m and there are two horizontal turbo-alternator sets, each of 20MVA capacity. The average production is 148 million units annually, that of the old station having been about 30 million units. The old power station was no longer in use when the new works were started, having become obsolete.

The dam will store sufficient water for operation of the power station at full load for six hours. It is 20m in height above stream bed level and about 60m long along the crest. It is faced with masonry, mainly for frost protection. For a length of 16·5m along the crest on the left bank side of the dam, there is a round crest spillway ; for 10m in the centre there is a gate house controlling a sluice gate covering an opening 8m high and 5m wide at the bottom of the dam, which permits the passage of silt and debris. Next to the gate house, along the crest, there is a sluice gate 10m long which is pivoted and balanced hydraulically, so that it is depressed when the water level rises. This gate is disposed under a footway leading to the gate house.

The right bank of the river is very steep and converges towards the centre of the stream at the dam site, so that it has been necessary to construct a substantial wall of masonry along it, which is stepped to dissipate the energy of the discharge from the top gate, which impinges on it. The three methods of spilling were essential since the flow of the Arly at this point varies from a minimum of less than 1 cubic metre per second, through a mean flow of about 7·5 cubic metres per second (10 cubic metres per second is the capacity of the power station) to a maximum flood of about 200 cubic metres per second.

Later on, a power station will be built near the dam, with an intake further up the river and a tail race aqueduct leading into the existing tunnel (the Flumet project). This aqueduct will make use of an adit driven near the tunnel entrance for the present stage of the work.

The power station of Ugine is of concrete construction partly faced with precast slabs. The concrete surfaces are tooled and painted with a proprietary varnish which keeps them free from dust. Each alternator is arranged with a horizontal shaft and is driven by two twin jet Pelton wheels. The power station also supplies water under pressure to the steelworks, so that its equipment includes pressure-reducing plant, and the tail race level is controlled by a weir which enables part of the flow to be utilised in the steelworks. There are two 20MVA transformers, stepping up the voltage to 42kV for transmission.

The Pelton turbines turn at 500 r.p.m. with a runaway speed of 930 r.p.m., under a net head varying between 355m and 376m. Each alternator is carried on two bearings, with a Pelton runner overhung at each side ; they are enclosed and self-ventilated units, generating normally at 7·5kV$\pm$10 per cent, 50 c/s, three-phase. The principal exciter is mounted between the rotor of the alternator and one of its bearings, and is equipped with

an electrically controlled rheostat in its excitation circuit. The pilot exciter is a two-pole machine coupled to one of the turbine wheels by a flexible shaft, and has a manually controlled rheostat in its excitation circuit. A standby pilot exciter, for the two sets, is provided. The frame of each alternator is of welded steel construction; in the magnetic circuit of the stator six electrical resistance thermometers are provided, so that the temperature of each phase may be measured by two of them. The rotor is made up of laminated steel discs, assembled by bolting. The laminated poles are fixed to the drum of the rotor by T-shaped keying, and the pole face is slotted for an amortisseur winding.

The Doron de Beaufort

A tributary of the Arly which is of considerable interest to the hydro-electric engineer is the Doron de Beaufort. The various power stations along this stream were shown in Fig. 1. Important new works are proposed to the south of this catchment, centred on the storage reservoir of Roselend. These works are described in Part V, but are mentioned here because the Roselend reservoir is shown on Fig. 22, which illustrates diagrammatically the various schemes on the Doron de Beaufort, showing the levels and installed capacities.

The six power stations beside the Doron de Beaufort have for many years relied upon natural seasonal storage provided by the lake of La Girotte. This lake is at an altitude of 1724m and is formed by a narrow ridge of rock separating it from the side of the valley, which descends steeply for about 500m. Within the last few years the natural storage has been increased by building a dam across the ridge and diverting various streams into the reservoir.

The lake has a natural capacity of some 30 million cubic metres, and was first used by constructing an intake at a level of 1710 N.G.F. at about the beginning of the present century. The storage thus provided was used in the winter by the power station of Venthon, the power being consumed by the paper mills of Aubry. In 1923 a second intake was constructed, at a level of 1645, 80m below the surface, enabling almost the entire capacity of the lake to be used. The natural catchment supplying the lake was only about 5 square kilometres, which did not yield sufficient run-off to fill it in the spring and summer, so that various diversion works were carried out to lead adjoining streams into it. The principal additions were from the Bon-Nant stream and Tré-la-Tête glacier. The first of these diversions was completed in 1932 and involved the construction of a tunnel 4·7km long; a catchment of 10·5 square kilometres was thus added to La Girotte lake, the stream being diverted at a level of 1910 N.G.F. The natural course of this stream runs northwards to join the River Arve. The Tré-la-Tête diversion is referred to in greater detail below; the intake works, at a level of 1934 N.G.F., are connected to the intake of the Bon-Nant diversion by a tunnel 5·3km long; this work was completed in 1944. Yet another measure to increase the storage was the installation of pumps in the Belleville power station in 1923, which function during flood periods. With all these measures the annual flow into the lake was estimated at 70 million cubic metres, of which 10 million was due to pumping. The dam, which was completed in 1948, is 48m in height above its lowest foundation level, and has increased the useful storage capacity to 50 million cubic metres (just over 40,000 acre-feet), thus enabling all the summer flows to be stored and utilised. The production of the power stations downstream was thus completely regulated and increased from 100 to 200 million kilowatt-hours annually.

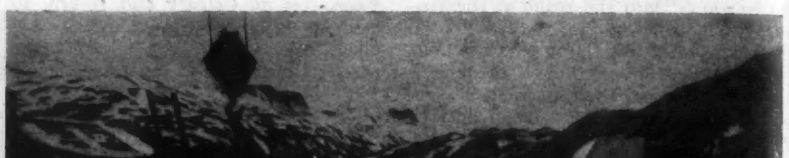


Fig. 24—Precast Facing Blocks—La Girotte

La Girotte Dam

The site of La Girotte dam is noteworthy for its inaccessibility. Access is gained by cable railway from the power station at Belleville, the ascent taking about twenty minutes. The width of the ridge of rock upon which the dam is built was one of the governing factors in its design; there was also a serious shortage of reinforcing steel at the time the work was started—during the occupation—and these two factors were largely responsible for the evolution of its final form.

Owing to the steepness of up to 40 deg. of the slopes on either side of the ridge—which is some 500m in length, with levels between 1720 and 1744, and with a slight concavity towards the lake (see Fig. 23)—an earth or rockfill dam and an arched dam were both impossible. The first design was for a gravity dam, but was considered somewhat uneconomical and unsafe on account of its vulnerability to uplift pressures and hence to sliding. The rock of the ridge was heterogeneous in nature, with soft and permeable pockets which could not be exactly located. It was therefore decided to investigate the possibilities of a multiple-arch design.

Details of the dam, as built, are shown in Fig. 23, the design of which was evolved by Professor Caquot and called "autostable." Previously, multiple-arch dams had been built of reinforced concrete, but reinforcement had to be avoided because of the lack of steel and also for another reason. The

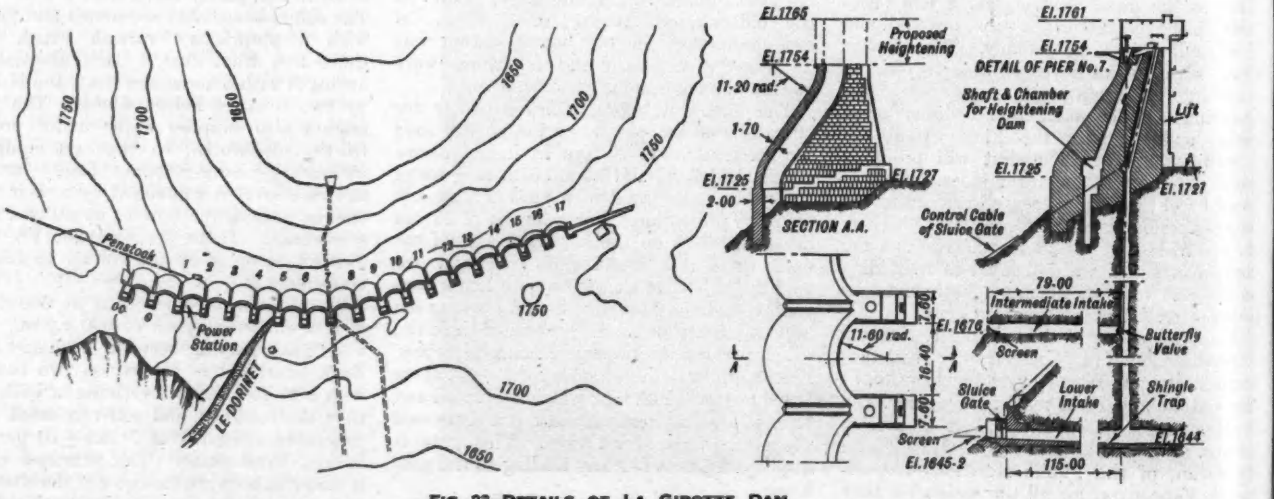


Fig. 23—Details of La Girotte Dam

dam is exposed to temperatures of —20 deg. to —30 deg. Cent. during four months of the year; due to reflection on sunny days this temperature may fluctuate up to 35 deg. or 40 deg. Cent. during this period. One of the first requirements was therefore a concrete which would be very resistant to frost. For this reason the arches are of plain concrete; they are spherical in the lower part, circular in the centre, and toroidal in the upper part. This configuration ensures that the resultant pressure passes through the same point in the base of the buttresses at all reservoir levels. The spacing of the buttresses is a function of the height of the dam and they are stable individually under all loading conditions. The arches are freely supported on the buttresses and are free to contract or expand to take up load and temperature variations; in practice there is only 2mm or 3mm of movement and a bituminous seal is provided at the springings.

The arches are actually thicker than is necessary for stability, but when they were built the frost resisting properties of the concrete were still under investigation. A laboratory was established on the site to study this problem and its work is discussed later in Part V of this article in connection with the Tignes dam, the conclusions given in Part V being equally applicable to La Girotte dam.

Provision has been made to heighten the dams in the future, if required, by the process evolved by Monsieur Coyne. The cross-section through one of the buttresses shows the shaft which has been left to accommodate a prestressing cable. When the addition is built the cable will be anchored in the footing of the dam and at the new top level, and will be prestressed to give an initial compression of sufficient magnitude to ensure that the resultant thrust due to the increased water load and the prestressing force will act on the base at the same point as under the original conditions. If this process is carried out the crest of the dam will be raised to a level of 1763 N.G.F. and the reservoir capacity increased to 59 million cubic metres.

It will be seen from the foregoing that Professor Caquot's design was of such merit as to make an extremely difficult project economically feasible. There are various other advantages which the design shows and which were abundantly clear in the design stage and during the difficult work of construction. The main drawback which had to be overcome was the complicated shape of the arch shuttering; this problem was solved by using braced steel trusses formed to the required shape to support the shutters. The resulting shuttering was not very much more expensive than that for a plane surface.

FIG. 26—DOWNSTREAM FACE OF LA GIROTTE DAM

The buttresses of the dam were faced with precast blocks of somewhat novel design, both to increase the resistance to frost, the blocks being of very high quality concrete, and to avoid shuttering. Each block has a face of 1·4m by 1m and is of the shape shown in Fig. 24, to provide a bond with the *in situ* work behind it. There was sufficient room behind the dam for crane rails to be laid along its entire length; other constructional plant and buildings were strung out along the ridge of rock and on the ground at either side, together with camp accommodation and various stores. Aggregates were obtained at a high elevation close to the dam, and all other material was brought up by two cable railways, one of which was used entirely for supplying cement. The illustrations herewith, Figs. 25 and 26, show the dam under construction; the low-level intake may just be seen at the bottom of Fig. 25.

The central buttress of the dam, which contains a lift shaft, is shown in Fig. 27; one of the arches adjacent to it is arranged as a spillway, with a stilling pool behind it. The capacity of the spillway is 6 cubic metres per second.

TRE-LA-TETE DIVERSION

Mention was made earlier of the intake works for diverting water from the Tré-la-Tête glacier. This glacier is the principal one to the south-west of Mont Blanc, being 7km in length and covering an area of about 11 square kilometres. The

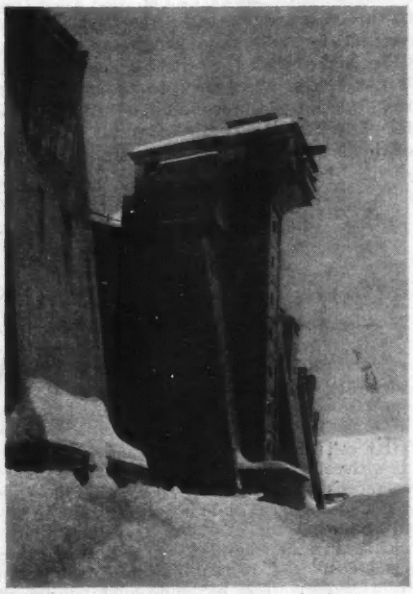


FIG. 27—CENTRE PIER OF LA GIROTTE DAM

diversion flows into the intake of the Bon Nant diversion, which is at a higher level than the Girotte reservoir, the available head at the downstream end of the tunnel (from which the water flows down a steep slope to the reservoir) varying between 140m and 180m. At present this head is being utilised by building a pipeline from the end of the tunnel to a power station under construction under one of the arches of La Girotte dam. The scaffolding for the construction of this power station may be seen under the arch in the foreground of Fig. 26. There will be two turbo-alternator

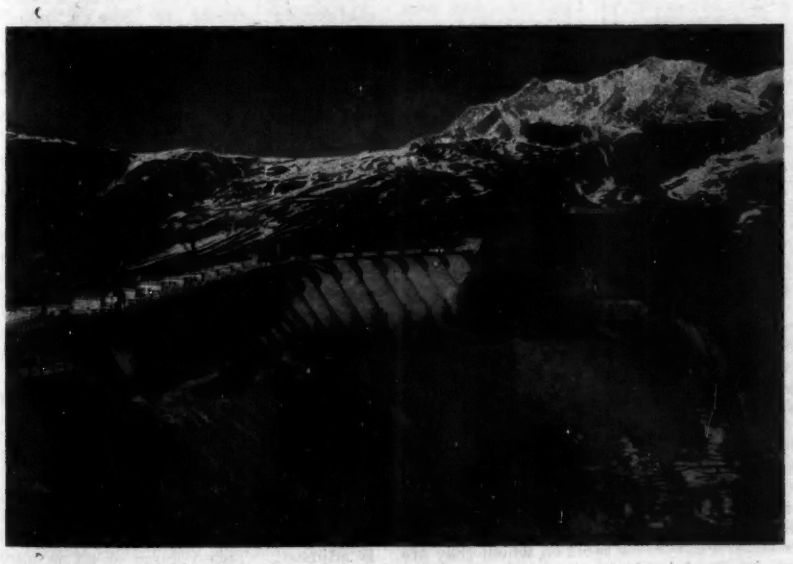


FIG. 25—LA GIROTTE DAM

sets, each of 7·4MW, in the power station, which will generate some 18 million kWh annually. The water will be discharged into the reservoir, the sets working against a back pressure when its level is high. The capacity of the diversion tunnel from Bon Nant and Tré-la-Tête is 6 cubic metres per second, and the flow obtained from it is from 30 to 45 million cubic metres annually, the upstream sill, which is 4m long, is therefore separated from the ice by a layer of water, which flows into the space between the sills to the diversion tunnel. At the depth at which the dam was built it was found that the ice was malleable in nature, a property which helped excavation work considerably. A sluice gate, 2m wide by 1·5m, for scouring out solid material, is incorporated in the

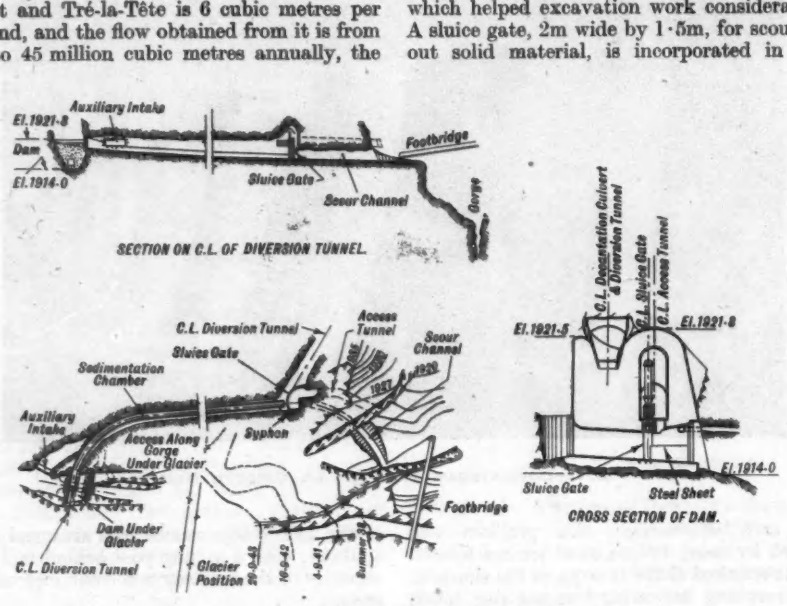


FIG. 28—TRE-LA-TETE INTAKE WORKS

higher figure corresponding to a warm and dry year.

The intake works at Tré-la-Tête are also of a somewhat remarkable character. The glacier ends in a narrow gorge and retreats about 10m annually. The intake dam was built under the glacier itself. Its general arrangement is shown in Fig. 28. Referring to the cross-section, it will be seen that the dam has two sills, the downstream one being 0·3m higher than the other. This higher one is faced with sheet steel, to protect it from the abrasion of the ice, and is 7m long. The formation of a reservoir of water upstream of the dam induces the ice to stabilise itself slightly below the level of the downstream sill, upon which the glacier rests. The dam; it is operated by remote control by an oil servo motor. The intake from the dam leads to a sedimentation chamber, with a sluice gate for scouring out solids similar to the one in the dam, a siphon of 6 cubic metres per second capacity for discharging spring floods, and the entrance of the diversion tunnel. The tunnel is provided with an automatic sluice gate just above its junction with the Bon Nant intake, so that at times of ample flow the Bon Nant water, which is of better quality, may be diverted to the lake in preference to that from Tré-la-Tête. A fuller description of this unusual work has been given by its designer, M. Waeber, in the *Annales des Ponts et Chaussées* of July-August, 1945.

(To be continued)

The Works of the Steel Company of Wales

No. VII—(*Continued from page 722, December 7th*)

THE roll shop is well laid out and is equipped with roll grinders and lathes. Bearing maintenance is also carried out here. This shop has direct access to the mill line. Rolls and bearings are removed by overhead travelling cranes which serve the length of the mill line and they are transported to the machine shop on a transfer car. The reconditioning equipment includes a 50in heavy-duty lathe and a roll grinder 52in by 22ft, and also a 32in by 22ft roll grinder.

Slab Heating Furnaces

We return now to the slab storage and reheating section of the mill, which was briefly mentioned earlier in this article. The slabs are pushed from the shear run-out table on to a transfer and cooling conveyor arranged at right angles to the mill line. On these conveyors the slabs are carried up and deposited on to a roller table on one side of the inner slab storage yard. From this table the cooled slabs are transferred to one of two pilers which loads them on to transfer cars for removal to the outer stock yard, where they are reconditioned, nspected and stored until required.

From the stock yard dressed slabs are moved to de-pilers for charging into one of the three slab reheating furnaces shown in Fig. 36. These furnaces were supplied by Stein and Atkinson, Ltd., and a fourth unit is later to be installed with the three at present in service. They are the largest continuous furnaces of their kind yet built in this country, and each is capable of heating 100 tons of slabs per hour from cold to rolling temperature.

The furnaces are "Rust" triple-fired units arranged for end charging and discharging. Three firing zones are provided, two for main heating with burners above and below the slabs, and the third for final soaking of the slabs before their discharge to the mill.

Each furnace is 88ft long from charging door to the apex of the discharge slope, and 20ft wide between inside walls. Slabs 18ft long can be charged in a single row and up to 9ft long in a double row. The slabs handled vary in width up to 60in and in thickness from 4in to 8½in.

Slabs are brought to the charging end of a furnace on a live roller table on which they are lined with the slabs already in the furnace before being pushed in by electric pushers. After passing through the furnace the slabs slide by gravity down a discharge slope on to the live roller table which takes them to the mill.

Slabs are supported through the furnace as far as the soaking hearth on heavy water-cooled skid pipes, which are themselves supported by vertical water-cooled pipes over the lower combustion chamber of the main heating zone. In order to economise in water consumption and conserve fuel, those portions of the skids and supports which are directly exposed to the flames are covered with a layer of plastic refractory held in place by welded studs.

The soaking hearth is built of high-alumina bricks and stainless steel skids. The discharge slope is of refractory material and is provided with water-cooled skids down which the slabs slide. These skids and the apex of the discharge slope are supported by heavy steelwork built in across the hearth. The water used for cooling the skids, &c., is cooled and recirculated.

The electric-motor-operated doors at both ends of the furnaces are each half the width of the furnace, so that only one side need be opened at a time when charging and discharging half-length slabs. Inspection doors are provided along each side of each furnace.

The furnaces are designed for firing with heavy fuel oil or coke-oven gas, and combination burners are installed for either fuel to be used at will. The arrangement of controls is such that either fuel may be used in any of the three zones irrespective of the fuel being used in the other zones. Oil is supplied at a pressure of 40 lb per square inch from a ring main system, and it is atomised by steam at a pressure of about 60 lb per square inch.

All the combustion air is preheated by passing it through refractory recuperators built under the furnace, the air being delivered to the burners by a specially designed motor-driven fan situated between the recuperators and the various burners. With the pressure thus imparted, accurate metering and control of air supply to each firing zone is obtained. The fan for each furnace has a capacity of 25,000 cubic feet per minute. The air is carried to the burners through mild steel mains lined with insulating bricks, with fibrous backing slabs between the lining and the platework.

The Stein recuperators consist of two chambers of special refractory blocks through which the air passes vertically, whilst the products of combustion pass horizontally through the passages formed between the blocks by the separating tiles. The blocks have machine-ground faces and are set with cold-setting cement to ensure tight joints, whilst providing freedom for expansion and contraction under changing temperature conditions.

The main furnace body is built of high-grade Scotch firebricks with double courses of insulation applied in many places. Water-cooled ties are embedded in the side walls of the main heating chamber, and the jointing is made with cold-setting cement to give a monolithic construction. The furnace roofs, nose arches and charging end vertical walls are of suspended interlocked block construction, the roofs being insulated.

A separate mild steel self-supporting brick-lined chimney provided for each furnace is 165ft high by 6ft 6in diameter inside the lining. The heat remaining in the products of combustion after they have passed through the recuperators is utilised in La Mont waste heat boilers fitted adjacent to each chimney. Isolating dampers are provided in the chimneys and in the connections to the boilers for by-passing purposes. Full automatic control enables the furnaces to be operated from 17ft 6in long control panels situated on raised platforms opposite the front of each unit. A comprehensive range of instruments enables the operator to assess the conditions in the furnaces and ensure correct furnace performance.

As mentioned earlier, a furnace has three firing zones and each of these is controlled for temperature and combustion ratio. The temperature control is effected from platinum/platinum-rhodium thermocouples in the zones, and through them the amount of air to the zones is adjusted. This volume of air is measured and the quantity of gas or oil and steam is

controlled proportionately to give the desired combustion ratio. The flows of air, gas and oil are indicated on gauges, and additional recorders are provided for gas and oil flows.

The furnace pressure is controlled and recorded. The control operates either the chimney damper or the damper in the connection to the waste heat boiler. Change of setting of either chimney damper or waste heat boiler damper is effected from the control panel. Instruments are provided for recording the temperatures of the waste gas entering and leaving the recuperators and for the air preheat temperature. The instruments are supplied with compressed air from motor-driven compressors, and oil pumps are provided for the combustion ratio and furnace pressure.

A comprehensive fuel oil pumping and heating system is provided to serve the furnaces. The oil is delivered from the bulk storage tanks

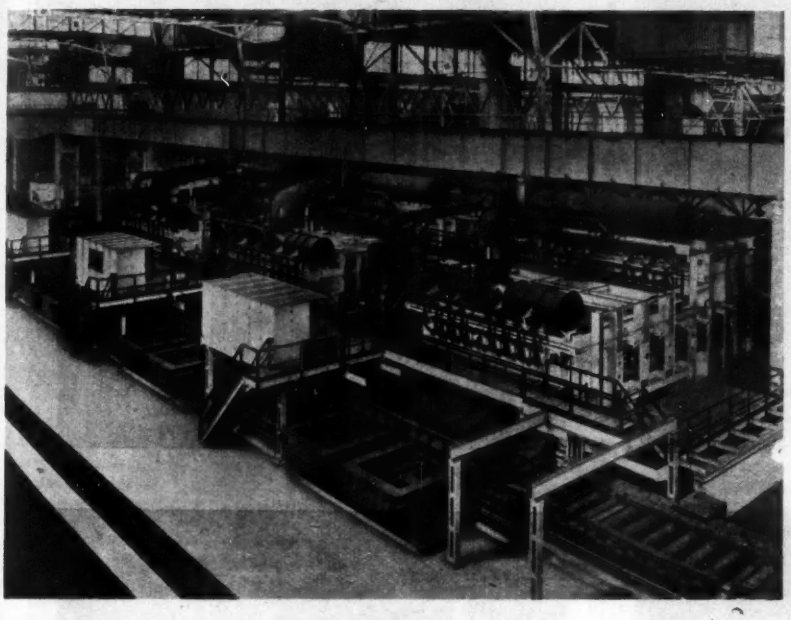


FIG. 36—SLAB REHEATING FURNACES

into two 10,000-gallon service tanks which are placed adjacent to the furnaces. Oil is drawn from these tanks by steam-driven pumps and automatic change-over valves are fitted in the delivery connections from the tanks so that the oil is drawn alternately from each. As soon as a tank is emptied the valves are automatically changed over by a controller so that the pump draws from the other tank, and a signal is sent to the main pumping station in order that the empty tank may be refilled. A coloured indicating light system installed to show which tank is in use and if the other tank is full or empty. A recording instrument is provided to show the level of the oil in each tank. Thermostatically controlled steam heaters in the tanks heat the oil to 90 deg. to 120 deg. Fah. and a temperature recording instrument is provided.

The two steam pumps (one of which is a standby) supply the oil ring main for three furnaces. These pumps have automatic control gear so that only the quantity of oil required at the furnaces, plus a small margin, is delivered to the heaters, ring main and the burners. By this arrangement the maximum economy in steam consumption is obtained.

Three vertical steam heaters are provided. Two heaters deal with the maximum quantity of oil to be heated, whilst the third is available for standby and can be immediately brought into use if one heater is taken out of service for cleaning. The oil temperature at the outlet of the heaters is controlled by a recording controller up to a maximum temperature of 260 deg. Fah., but is capable of regulation to the correct temperature for the grade of oil in use. Coarse mesh filters are fitted between the service tanks and the pumps, and fine screen filters are fitted in the supply pipes from the ring main to each furnace. The oil circulated through the ring main is kept at temperature by steam tracer piping, the temperature being thermostatically controlled in sections of suitable lengths. The oil pressure in the ring main is controlled by a hand-set sustaining valve and the pressure is recorded. The return pipe of the ring main is connected to the circuit between the tanks and the pumps, or the oil may be returned to the tanks. Large platforms at the sides and front of the furnaces, to give easy access for attention and maintenance, and walkways, provide free access to the burners of all three zones.

With the exception of the waste heat boilers in the design of which Stein and Atkinson, Ltd., co-operated with the consulting engineers and the makers, the complete installation has been developed and installed by that company, which co-operated with the Rust Furnace Company of Pittsburg in respect of the main features of the furnace.

The plate and hot sheet finishing departments, together with the cold reduction plant at the Abbey works, are now in process of commissioning. In this section a wide selection of plant supplied by the United Foundry and Engineering Company of America, the Wellman Smith Owen Engineering Corporation, Ltd., the Head Wrightson Machine Company, Ltd., the Davy and United Engineering Company, Ltd., W. H. A. Robertson, Ltd., and a number of other firms, is being installed. When this additional plant is in operation the final production sequence of the works can be dealt with in detail. We therefore propose to close our descriptions of the sheet steel production lines at the coiling stage, and when the rest of the plant has been commissioned a further series of descriptive articles will be published in THE ENGINEER. To conclude the present series of articles we deal with the large engineering shop which serves the works.

THE CENTRAL REPAIR SHOP

A point of particular importance in the running of a works as large as that of the Steel Company of Wales at Port Talbot is the services of a well equipped engineering shop, which is not only capable of effecting normal overhaul and maintenance work on a variety of plant, but is always available to undertake emergency repairs. All engineers will appreciate that if such facilities are not immediately available on site even a small breakdown in one section of the production line can ultimately involve a considerable loss of time and output. Also when laying down a new works of such size, many items, small in themselves but nevertheless essential, are apt to be overlooked when planning and often, if they cannot be expeditiously made on site, involve expense and waste of time to procure. For these reasons a large engineering and maintenance shop, planned on the estimated requirements of the works, was built and equipped at one of the earliest stages in the main construction scheme. It was used to provide maintenance for the existing works at Port Talbot and Margam, to supply urgent needs for parts during the constructional work, and to provide maintenance facilities as plant was put into operation at the various stages of the main scheme.

To give some impression of the scope of this works and its equipment it might be pointed out that it is designed and equipped for the repair and maintenance of the coke ovens, blast furnaces, melting shops and other plant at Port Talbot and Margam, the melting shops, hot and cold mills at Abbey works, and other works services such as the maintenance and overhaul of locomotives, rolling stock, ladle cars, dock equipment, &c. The calculation, equipment, design of lay-out and supervision of erection of the works was undertaken by the industrial consultant, Dr. H. Orenstein, whose chief assistant on the work, Mr. A. Henderson, is now the works manager. The structural work, which was designed by W. S. Atkins and Partners, was carried out by A. E. Watson and Co., Ltd., the contractors for the civil engineering side of the work being Sir Robert McAlpine and Sons.

When this engineering works—known as the Central Repair Shop—was completed an existing maintenance shop at Margam was converted to deal expressly with electrical repairs and maintenance and its staff and equipment, together with that from a smaller shop at the Port Talbot mills, was transferred to the new works, which is situated at a central point between the blast furnaces and melting shops at Margam and the new Abbey melting shops and rolling mills. Adequate road and rail transport facilities are available from this site to all other parts of the works.

At each end of the engineering works are large concrete storage platforms, on one of which parts requiring dismantling for repair are handled and on the other raw materials are stored. The dismantling platform, to be seen on the right in the photograph we reproduce on page 759 (Fig. 41), is served by two railway tracks and a third track passes through the shop across the ends of the bays. A traverser across the end of the building is used to transfer rolling stock and wagons carrying heavy equipment for repair to tracks running into other parts of the works. A steam cleaning station by one of the main ingoing tracks, is used to remove dirt and grease from equipment before it is taken into the workshops.

The Central Repair Shop is 330ft long by 300ft wide and consists of five bays. In these bays, two of which are 75ft wide and three 60ft wide, the columns are spaced at 40ft. A two-storey office block is built into the main structure along the full length of the east side of the building. This office block is a brick-built structure and blends well with the painted corrugated sheeting with which the remainder of the building is walled. Ample natural lighting is provided by deep, curved glazed panels in the end walls and vertical glazing in the high-low roof. The roof is of corrugated aluminium sheet and "Tentest" board treated with bitumen and limestone chippings. Each bay is served by an overhead travelling crane, the rails for those in the 75ft bays being 30ft and those in the 60ft bays 22ft above floor level. To provide access to the cranes a full length walkway is built on one side and a short platform on the other in each bay, and the walkways terminate on the roof of the office block. Excellent overhead general artificial lighting is provided and walkways, giving access to the lamps for cleaning and changing, also provide access to all parts of the roof structure.

The main overhead lighting is provided by fittings with a combination of two high pressure

CENTRAL REPAIR SHOP, ABBEY WORKS, STEEL COMPANY OF WALES

FIG. 37—LOCOMOTIVE REPAIR AND BOILER SHOP

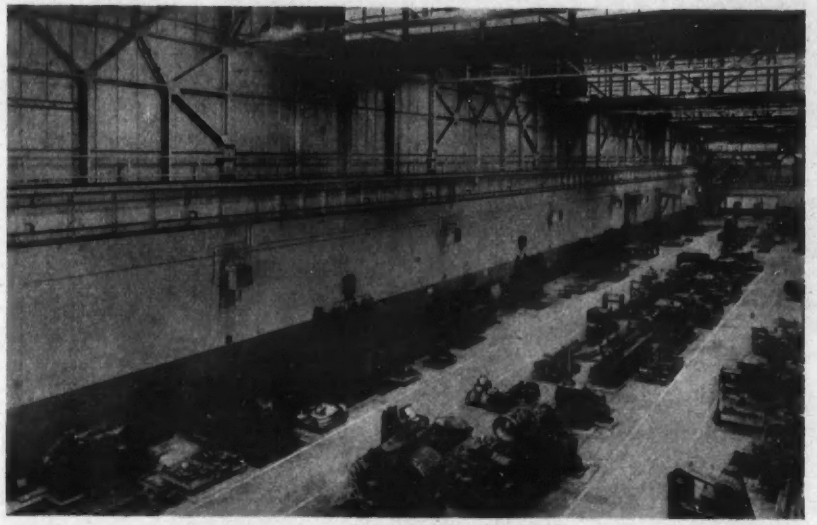


FIG. 38—LIGHT FITTING AND MACHINE SHOP

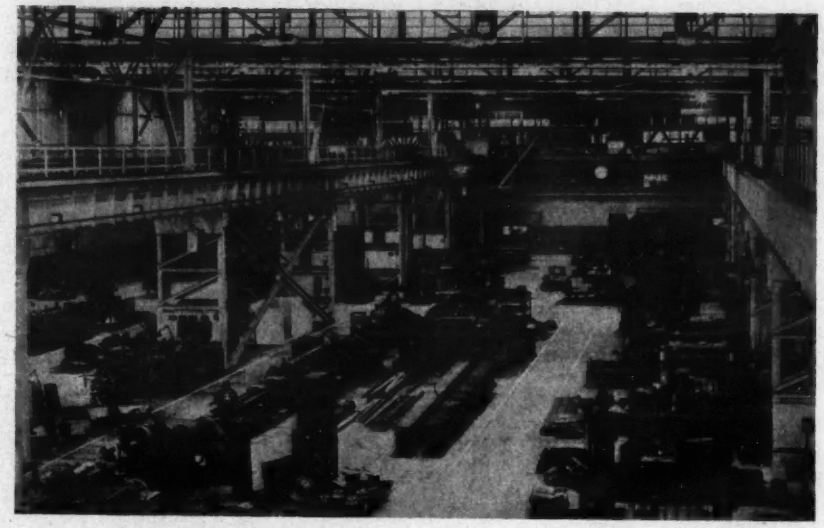


FIG. 39—HEAVY MACHINE AND ERECTING SHOP

FIG. 40—STORES AND SMITHY

mercury vapour discharge lamps and one tungsten filament lamp, and it gives an average intensity of 25 foot candles at floor level in most of the bays, and 12 foot candles in the smithy.

The building is warmed throughout by overhead unit heaters and a high pressure hot water system supplied by two boilers in an adjoining boiler-house. The hot water pipes, together with the service water, compressed air, oxygen and coke oven gas lines, which serve all parts of the shops, are run under the crane walkways and down to floor level through the building columns.

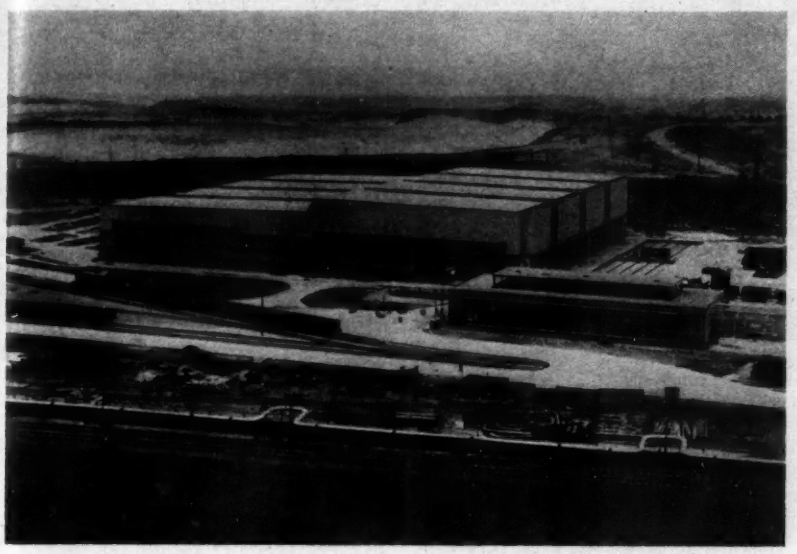


FIG. 41—CENTRAL REPAIR SHOP

The nature and variety of the work carried out in the shops makes it difficult to adhere to any rigid sequence of flow but generally it is arranged to run from west to east—that is, from the back of the building towards the front, as seen in our illustration. It runs through the natural sequence of machining, fitting and assembly.

Rolling stock and locomotives are repaired in the first bay, a corner of which can be seen on the left in Fig. 37. A series of tracks across the width of this bay are served by the traverser, which transfers the vehicles after they have been cleaned from one of the two main incoming lines to the appropriate track in the shop. Diesel locomotives are handled on the first two tracks, steam locomotives on the next four tracks and the hot coke car from Margam on the next track, the entrance of which has a specially large door 18ft wide. A number of other tracks are used for steam cranes, ingot cars, wagons and other forms of rolling stock. In six of the tracks pits 3ft 6in deep by 4ft wide and having special wall lighting, are provided to facilitate work on the under parts where complete stripping down is not called for. To handle the heaviest locomotives used in the works, which weigh about 100 tons, there is a set of four 25-ton electric jacks, which, when in position, can be operated individually or collectively by means of push buttons. Ample space is provided by each track for handling large units during dismantling and overhaul. This bay is served by two overhead travelling cranes supplied by Clyde Crane and Booth, Ltd. One of these cranes has a capacity of 25 tons and the other 15 tons, the span being 66ft.

Adjoining the rolling stock repair bay is the boiler shop and welding section, also to be seen in Fig. 37. Work is arranged on two lines—plate and structural—in this bay, and generally flows from the storage area at the lower end to the finishing area at the upper end, where the railway track is available for removing the boilers, melting shop ladles and other heavy components. A good range of modern machines installed for plate working includes bending rolls, punching shears, a profile cutter, welding manipulators, &c. Facilities are also available for pressure testing locomotive steam boilers before they leave the shop. Electric overhead travelling cranes with a span of 68ft 6in. and of 20 and 5 tons capacity, made by Clyde Crane and Booth, Ltd., serve the length of the bay.

The two heavy shops dealt with above are separated from the adjoining light fitting and machine shop shown in Fig. 38 by a brick wall, which effectively reduces the noise associated with boiler and plate work. A heavy machine and erecting shop (Fig. 39) is laid down in the next bay. Both of these shops are well equipped with modern machine tools, which have been carefully selected to cover the full range of machining requirements of the plant in the main works. All of the machines are well spaced and despite the amount of large work in hand there is no suggestion of congestion. This freedom is in a large measure due to the extensive storage area in the yard outside the building and the plentiful handling equipment, by which work can be quickly and easily transferred in and around the shops. At the lower end of the machine bays a tool-room has been installed to deal with all tool grinding as well as the manufacture of tools, jigs and fixtures. In the last bay of the works adjoining the heavy machine shop is a raw material stores, pipe shop and the smithy, shown in Fig. 40.

The overhead crane lifting facilities in the shops are supplemented by one 6-ton mobile crane and one 1-ton mobile truck crane, and numerous pillar cranes at stations adjoining heavy machines and where heavy erection is carried out.

The smaller building, to be seen on the right of our illustration of the Central Repair Shop, is a wood-working shop and stores. In this shop wood from the timber stores enters one end and passes through the machine lines in sequence of operation to the assembly section at the other end of the building.

On the site behind the timber store it is planned to erect a paint shop. This has been arranged to handle all the painting of locomotives, rolling stock, road transport vehicles, and other painting, and will be the source of supply for all maintenance painting throughout the plant.

In a works of this kind a high percentage of skilled labour is necessary and, to ensure a good supply of such labour in the future, a comprehensive apprentice training scheme has been organised. Before the apprentices begin their training they first spend six months in the main works, where they work for a few weeks in different parts of the furnaces, coke ovens, mills, &c., to get the general "feel" of the organisation. At the end of this period they start work under skilled instructors—in a well equipped machine and fitting shop laid down in a gallery at one end of the machine bays in the Central Repair Shop. The apprenticeship scheme is designed to produce at the end of five years a skilled general machinist and fitter, able to specialise in any particular branch in which he is interested.

The organisation and planning of work in this establishment calls for close co-operation between its management and the heads of the various sections of the main plant. Such organisation has, of necessity, to be flexible in order to do the work in the order of priority, and an up-to-the-minute knowledge of every job on the shop floor is essential to make possible quick changes to carry out urgent repair and maintenance work when it arises. A chart system has been introduced in the planning section to keep a constant check upon machine loading so that work can be carried out at the highest possible speed. Paper work has been reduced to the minimum and progressing of work is carefully controlled by direct contact between the office and the shop floor. Advance estimating is not practicable but an effective costing system makes it possible to show the price of a job within a few days of the completion.

Dredging and Reclamation at Southampton

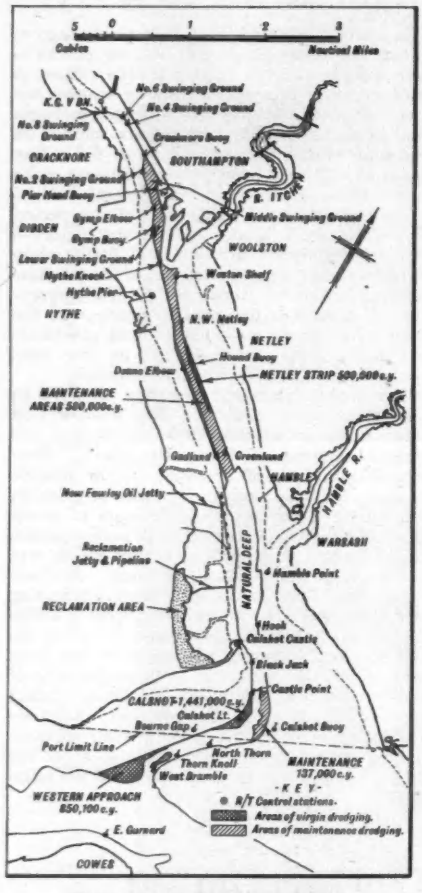
DURING the past two years, some interesting work has been in progress at the port of Southampton, where the largest dredging and reclamation contract which the Southampton Harbour Board has undertaken up to the present has recently been completed. Altogether, some 3,500,000 cubic yards of spoil have been removed, about 2,000,000 cubic yards of which were employed to reclaim an area of some 200 acres of marshland. The rest of the spoil was dumped at sea.

Between the years 1882—when the board first took parliamentary powers for deepening the waterways of the port and the approaches—and 1907, the main channels of the port were dredged to a depth of 32ft M.L.W.S. to accommodate such famous ships as the "Majestic," "Teutonic," "Olympic," and "Titanic." The increasing draught of vessels meant that between 1922 and 1927 continuous operations for widening and deepening were demanded, not only in the reaches above Fawley up to the docks, but also in the natural channel below Calshot down to the south-western extremity of the Brambles shoal.

In 1931 the board commenced the largest single dredging contract undertaken up to that date, involving the excavation of 2,750,000 cubic yards of material, to widen the channel, where possible, to 1000ft, and to deepen the reaches below Calshot to 38ft M.L.W.S. Thus, when the "Queen Mary" came off the stocks, Southampton was ready to receive her with her 39ft load draught. The second world war deferred plans for further dredging, but after the war the board decided on a programme for the rectification of the docks to Fawley reaches, the Calshot Spit and Western Approach, to facilitate the entry of the largest ships. Accordingly, in 1950 work was started on the contract which is the subject of this article. The parts of Southampton Water which were dredged may be seen from the map which is reproduced on the next page.

In the Western Approach Channel the work included dredging away the port hand western margins off the West Bramble light buoy up to the Bourne Gap light buoy to a least depth of 38ft below Port Low-Water Datum. The widening of the entrance to this reach was designed to give a greater freedom for ships to turn on their inward voyage. It is understood that the benefit of this work has already been felt and favourably commented on by the pilots and commodores concerned. The quantity of spoil removed here was about 850,000 cubic yards.

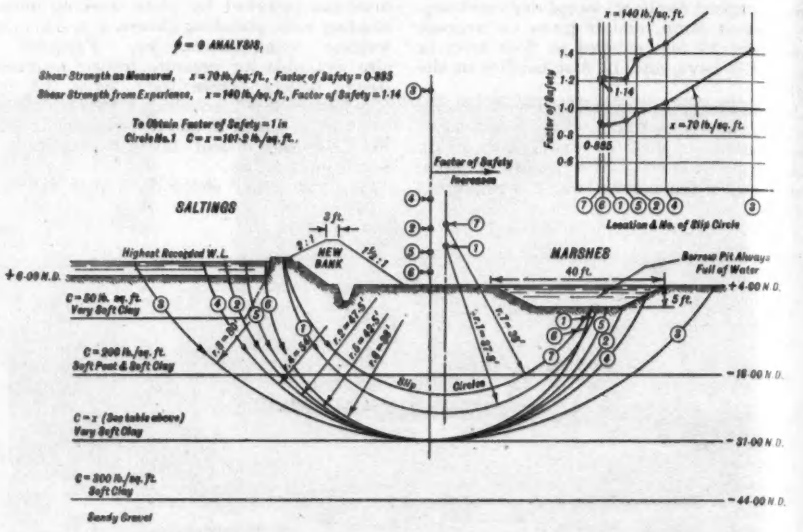
Dredging away the eastern corner of the Calshot Spit to a 4000ft radius curve, and continuing the straight port hand approach dredged in the Western Approach Channel, as shown in the illustration, was carried out to give an easy turn for large ships, increasing the depth in this area to 38ft P.L.W.D. Here it may be remarked that the liners "Queen Mary" and "Queen Elizabeth" draw up to



DETAILS OF DREDGED AREAS

40ft and may, due to hydraulic factors, increase their draught by another 2ft in shallow water. The provision of sea channels for such extreme dimensions of length and draught in manœvring is a requirement in this country which Southampton alone is obliged to meet. The greatest width of the channel off the Spit has now been increased from 1650ft to 2500ft, and the quantity of spoil removed was just under 1,500,000 cubic yards. Where excavation was necessary from a depth of 8ft to 38ft below P.L.W.D., a 50ft wide terrace has been cut between the 1 : 3 slopes to ensure their stability. It is not expected that any appreciable silting of the two dredged areas mentioned above will occur.

Between Calshot Castle and Fawley lies the Natural Deep, having depths well over 42ft below P.L.W.D. Above Fawley and the new Esso Marine Terminal lie those reaches of the main channel which extend up to Cracknore, off the New Docks, and have hitherto required constant dredging by the board; a drastic rectification of the starboard hand and easterly margins lying between the N.W. Netley light buoy and shoal, and the Cadland light buoy,


ϕ = 0 ANALYSIS.
Shear Strength as Measured, x = 70 lb./sq. ft., Factor of Safety = 0·885
Shear Strength from Experience, x = 140 lb./sq. ft., Factor of Safety = 1·14
To Obtain Factor of Safety = 1 in Circle No. 1 C = x = 101·3 lb./sq. ft.
Factor of Safety Increases
SALTINGS
3 ft.
NEW BANK
Highest Recorded W.L.
+6·00 N.D.
MARSHES
40 ft.
Borrow Pit Always Full of Water
+4·00 N.D.
5 ft.
C = 50 lb./sq. ft. Very Soft Clay
C = 200 lb./sq. ft. Soft Peat & Soft Clay
Slip Circles
-16·00 N.D.
C = x (See table above) Very Soft Clay
-31·00 N.D.
C = 300 lb./sq. ft. Soft Clay
-44·00 N.D.
Sandy Gravel
x = 140 lb./sq. ft.
x = 70 lb./sq. ft.
Factor of Safety
1·4
1·2
1·0
0·8
0·6
1·14
0·885
Location & No. of Slip Circle

STABILITY ANALYSIS OF THE BANK BUILT IN ONE OPERATION

has been made by dredging in alignment with the dominant tidal ebb scour. The axis of the channel is now some 250 eastwards, and the eastern margin 400ft eastward, of their old positions; the channel is now in a terrain not so liable to silting. The quantity of material removed in the reaches above Fawley was just over 1,000,000 cubic yards.

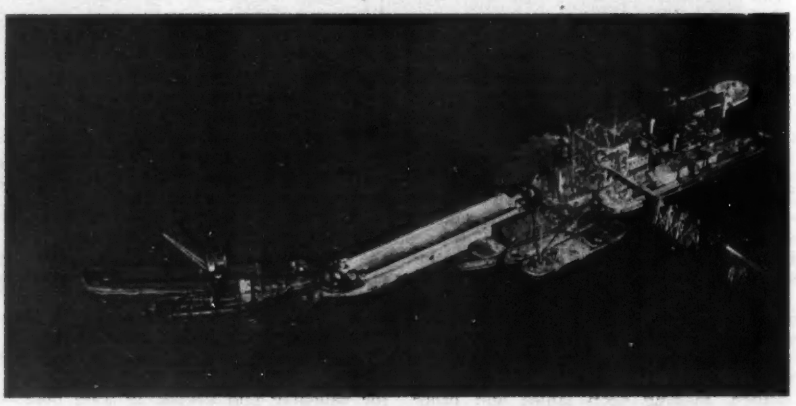
Reclamation

Large quantities of the dredged material have been disposed of by pumping into reclamation areas ashore, which are situated at the base of the hills on the western side of Southampton Water, between Fawley and Calshot, and lying at a level of about 6ft below highwater. Embankments were constructed by dragline excavators and material was pumped ashore inside the enclosures formed by them, the total area reclaimed being approximately 200 acres. A pipe-line jetty consisting of timber piles and light steel truss spans was constructed to convey the pipe-line from the reclamation dredger into the enclosed reclamation areas about 800 yards inshore from the low water line. About 2,000,000 cubic yards of the total dredged material had been pumped into the reclamation areas when the contract was completed. A quarter of the area of the new land has been sown with grass seed and, when completely drained and settled, will be suitable for agricultural purposes, and, it is estimated, will be fit for grazing in two years.

One aspect of the reclamation work which is worthy of a more detailed account is the soil mechanics analysis which was carried out to investigate the stability of the new embankment, and the allowable depth of dredged material which might be placed in the reclamation area. The borings and soil tests indicated that conditions throughout the site were somewhat similar, but the shear strength tests of the various clays gave rather unusual results. The shear strength reached a value of some 200 lb per square foot at a depth from 10ft to 25ft, but then decreased in the range 25ft to 40ft to a measured value of 70 lb per square foot, whereas the value expected from experience was about 140 lb per square foot. At depths of 40ft to 50ft the shear strength increased again to about 300 lb per square foot, as expected.

The design of the bank is shown in the diagram above, the maximum height being 10ft. As may be observed, it was built against an existing bank, which was in fairly good condition and was protected by brushwood from erosion on the seaward side. The design assumed that the soil excavated from the borrow pit was to be allowed to dry out and thereby increase its strength, and construction in two stages, which would also allow the soil to increase its strength, was recommended. A slip involving the bank and the borrow pit was considered to be more critical than one of the bank alone. Various possible slip circles for the $\phi = 0$ analysis of such a failure are shown in the diagram. To guard against this possibility the minimum dimension of 20ft between the bank and the borrow pit and 5ft for the maximum depth of the pit were stipulated. Furthermore, it was suggested that the pit should be kept full of water. A slip to the seaward side, prior to placing the fill, was not considered likely as the level of the saltings was above that of the marsh; however, there were numerous creeks in the saltings, and where one of them approached the line of the bank the latter was set back.

It was considered that if the bank was to be built in one operation the shear strength of the soft clay below the peat would have to be more than twice that measured in the laboratory.



DREDGER AND ANCILLARY CRAFT AT PIPELINE JETTY

This was considered to be possible, since it is difficult to sample very soft clays. Any disturbance of the soil would produce a reduction in the shear strength and vane tests were recommended to overcome this difficulty. However, the only important consideration in the event of a failure was that no dredged material should find its way back into Southampton Water. The contractor therefore decided to build the bank in one operation, keeping a sharp watch for signs of slip and taking prompt remedial action, by removing the top of the bank or reinforcing it with timber,

PIPELINE JETTY AND RECLAMATION AREA

should a slip occur. In fact, slips did occur, particularly when the borrow pit was empty, but it was still considered that the right method of construction had been adopted.

The criterion for determining the allowable depth of fill was considered to be the possibility of a slip involving a settlement of the bank and fill behind, and a corresponding heave in the area of the saltings. For such a slip the factor of safety was found to be 1·33 for a depth of fill of 7ft using the measured strengths including those of the soft clay. For a depth of 8ft the factor of safety was 1, with the strengths of the soil as measured except for the very soft clay, which required a strength of 100 lb per square foot. It was therefore decided to place 8ft of fill over the area. The possibility of lateral flow of the soft clay was also considered, the likelihood of which was greatest where the width of the reclamation was least, i.e., about 600ft. For this width a factor of safety of 1·1 was calculated, using the measured value of the strength of the soft clay. At a later date, when the fill has consolidated and the shear strength of the clay underneath consequently increased, a further 2ft of fill will be placed over the area to bring it to the level of the top of the embankment.

During the work the reclamation dredger was permanently stationed at the end of the pipeline jetty and was used simply as a floating pumping station. The pipe-line bifurcated where it entered the reclamation area, and pumping could be carried on continuously, one arm of the pipe-line being moved into position whilst the other arm was in use. Three temporary culverts were provided to allow the water to escape after the fill had settled. The accompanying illustrations show the reclamation dredger at work emptying barges at the pipeline jetty and the pipe-line across the saltings to the reclamation area.

During the peak period of the work three large bucket dredgers were employed, with ten self-propelled seagoing hoppers, seven dumb barges, the reclamation dredger mentioned above, and tugs and ancillary craft. A total labour force of about 250 men was employed, and the contract was completed in six months under the scheduled time of twenty months. The contractors to the Southampton Harbour Board were the Dredging and Construction Company, Ltd., of King's Lynn, Norfolk, and the soil mechanics report was prepared by Soil Mechanics, Ltd., 123, Victoria Street, London, S.W.1.

Now that the dredging programme has been completed the board, in consultation with Trinity House, is now examining all the buoys, beacons and other navigational aids in the port area, where considerable revision is planned to conform with the improved approaches and channels and, where necessary, new navigational aids will be provided. A further subject now being investigated by the board is the provision of a port control and information service, which will embody the use of radar and radio telephone. It is planned to provide full information to shipping interests to assist in the safe and quick handling of vessels in the port.

The History of Machinery for Paddle Steamers

On Tuesday, November 20th, Mr. G. E. Barr read his paper, entitled "The History and Development of Machinery for Paddle Steamers," before the Institution of Engineers and Shipbuilders in Scotland, which we summarise below.

The paper gives an historical review of the development of the paddle engine from the side lever to the diagonal design and typical engines are illustrated with drawings. To William Symington goes the honour of first applying paddle wheel propulsion when he fitted a horizontal double-acting engine in the "Charlotte Dundas," to drive a stern wheel, and the next noteworthy vessel was Henry Bell's famous "Comet." Over the years 1810 to 1940 four main designs of machinery were fitted to paddle steamers and were as follows:—1812–1854, side-lever engines with a working pressure 5 lb to 25 lb per square inch; 1835–1866, Steeple engines working at 25 lb to 155 lb per square inch pressure; 1825–1880, oscillating engines working at 30 lb to 150 lb per square inch pressure, and 1844–1940, diagonal engines with a working pressure of 50 lb to 220 lb per square inch. Each engine is illustrated and described and a list gives the names of the builders of the early engines.

Various design details are discussed such as crankshafts, valves and valve gear, and also the development stages of condensers and auxiliaries such as air pumps. Following upon a brief review of stern wheel steamers there is a section of the paper devoted to paddle wheels, and the gradual evolution from the earliest designs with radial float paddle wheels is described and illustrated with several drawings. It is noted that the radial wheels of the "Great Eastern" were 58ft in diameter and ran at 11 r.p.m. The feathered wheel was invented to satisfy demands for more power and faster running machinery, and there were several novel forms such as the caterpillar arrangement and cycloidal design. Feathering gear is briefly described and it is stated that no great changes had taken place in the method, first introduced in 1835, until 1948.

Since the time of Symington, the boilers used in paddle steamers have developed considerably. The early box boiler was only suitable for pressures up to 30 lb per square inch and was replaced by the haystack boiler built to withstand 100 lb per square inch. On account of its good steaming capacity and light weight, the locomotive boiler was adopted and a development of this design was the Navy boiler, which could give a high rate of evaporation, and had a working pressure of 200 lb per square inch. The advantages of the Scotch boiler were soon realised, but the water-tube boiler never became popular.

The materials available are mentioned and also the main factors affecting the lay-out of the machinery. In his conclusions the author states that the days of the paddle wheel steamer are not over, and gives brief notes of the successful application of diesel engines driving the paddle wheels through mechanical gearing or an electric drive.

Emergency Lighting in a Mental Hospital

The cost of wiring for emergency lighting systems operated from a central battery can be prohibitive in the case of mental hospitals arranged in the form of a "spider," consisting of a series of chalets, for housing patients, at points radiating from a central building. In Shenley Mental Hospital, Shenley, Herts (opened by King George V in 1934), Mr. H. B. Hopps, the group engineer for the Shenley hospital group, has overcome the difficulty by installing sixty G.E.C. emergency lighting units. Each of these units is self-contained and embodies a battery charger and lamp in one case which is small enough to be installed in the most favourable position for use in emergency. At Shenley the lighting equipments are mounted out of reach of the patients, about 10ft from the floor, and in such a position that with one extra lamp wired from the unit they can throw light into both wards and recreation rooms.

Each unit is left connected to the mains supply, a small neon indicator lamp showing that the unit is in circuit. The battery is kept fully conditioned by a charger which forms a part of the unit; the lamp is kept normally "off" by an internal relay, which, immediately the supply fails, changes to the "on" position. For testing it is only necessary to switch off the power; the emergency light will then come on, fed from an internal battery. A maximum of 60W of lighting can be supplied from each unit by using two lamps. The period of use varies from 1¼ hours with a lamp load of 60W to 5¼ hours with a lamp load of 24W, which is enough for the usual power cut.

When the supply is restored the lamp is automatically switched off, the charging begins, and in forty hours a fully discharged battery is completely restored. Should there be another breakdown or blackout within ten to fifteen hours the lamp can be used for a short period. Overnight recharging allows, in most cases, for further limited use the next day.

The 6V, 29Ah Exide accumulator fitted is a low-loss unit especially suitable for trickle charging. For charging the battery a G.E.C. selenium rectifier unit is housed in its own compartment inside the case, and it can be withdrawn if necessary as a single unit. It is only necessary to top up the batteries approximately once every three months in average room temperature. The electrolyte level can be seen through inspection holes provided in the side of the case or by opening the case and removing the cell stoppers.

Agricultural Machinery Exhibition at Earls Court

No. III—(*Continued from page 735, December 7th*)

THE Smithfield Show and Agricultural Machinery Exhibition, which took place at Earls Court from Monday to Friday of last week, attracted the biggest number of visitors since 1903. The attendance on the five days totalled 66,003, compared with 49,381 last year. It has been reported that the orders received by the machinery and equipment exhibitors during the period of the show are estimated at about £12,500,000, more than half of that amount being export business. In what follows we conclude our description of some of the implements and machinery displayed on the trade stands.

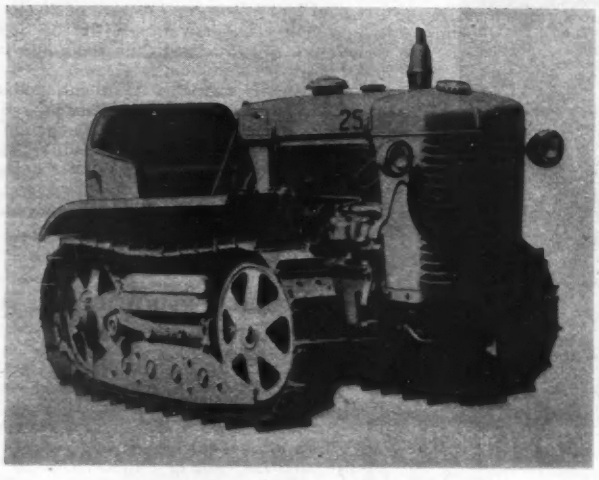


FIG. 12—25 B.H.P. FIAT TRACTOR—MACKAY

FIG. 13—LOW VOLUME SPRAYER—WEEKS

Among the tractors of Continental origin which were exhibited at Earls Court last week were two recent additions to the Fiat series. They were shown by Mackay Industrial Equipment, Ltd., Faggs Road, Feltham, Middlesex. One of these tractors, the Fiat 25, is illustrated by Fig. 12. It is a crawler tractor fitted with a Mackay hydraulic power lift which is adaptable to practically all makes of cultivating implements with a three-point linkage. The tractor is powered by a Fiat four-cylinder, four-stroke side valve engine developing 25 b.h.p. at a governed speed of 1750 r.p.m. when running on paraffin, giving the tractor a belt horsepower of 22 and a drawbar horsepower of 18. The magneto ignition incorporates an impulse coupling to make starting easier. Engine cooling is effected by a six-bladed fan, with a centrifugal pump to assist the water circulation, both being driven through the timing gears. There is a single-plate over-centre master clutch, which can be removed without disturbing the engine or gearbox, and provision is made for four forward speeds and one reverse. The forward speed range is from 2·1 to 6·6 m.p.h. The forced feed lubrication is by twin gear pumps, which are mounted at the forward end of the sump, the auxiliary being provided to prime the main delivery pump irrespective of the angle at which the machine is operating. For filtering the oil there is a self-cleaning disc filter, which can be rotated while the engine is running and which is supplemented by a secondary filter with a replaceable cartridge.

The multiple-plate steering clutches of the Fiat 25 are actuated by steering levers. When the clutches are fully disengaged the steering levers come into contact with the brake control linkage, so that any further movement of the levers operates the brakes. This combined control ensures that the brakes are released before the steering clutches are re-engaged. The brakes can also be operated by foot pedals, and in addition there is a hand-operated parking brake. The spur reduction final drives are fitted with ball and roller bearings; the assemblies, together with the sprockets and clutch drums, can be removed as complete units and are interchangeable.

The track gauge, from centre to centre, is 3ft 1¾in, and there are thirty-three track shoes, each 8in wide, to each track, the ground contact being 760 square inches. The track release mechanism is totally enclosed in an oil bath from which all four bottom rollers are automatically lubricated. The fully oscillating track frames are supported on a main cross-shaft at the rear, and by a heavy-duty semi-elliptical transverse leaf spring at the front. Track frame alignment is maintained by a transverse tie bar.

Another tractor exhibited by Mackay Industrial Equipment, Ltd., was the Fiat 55,

FIG. 14—GRADER AND EARTH SCOOP—TASKERS

equipped with a Mackay angledozer. The four-cylinder Fiat engine in this tractor develops 55 b.h.p., giving a drawbar horsepower of 45 and a minimum drawbar pull of 12,125 lb. The angledozer blade is 14ft 0½in long and 2ft 7in high, and has a cutting edge ½in by 6in by 7ft 6in and a maximum tilt of 1ft 8in. The angledozer can be lifted 2ft 7in above the ground, hydraulic pressure being provided by a constant displacement gear pump mounted at the front of the tractor. The blade is carried in the centre by a swivel joint and at the sides by torque tubes. It can be set for tilt or roll by screw adjustment of the torque tubes.

In Fig. 14 there is reproduced a photograph of a grader and earth scoop manufactured by Taskers of Andover (1932), Ltd., Andover, Hants. This equipment, which was shown mounted to a Fordson tractor, can be conveniently used in various earth-moving operations, such as soil conservation and contouring, the shaping of road surfaces and cutting banks and edges. The scoop is constructed from ½in thick steel plate and is electrically welded throughout. It is 4ft wide, weighs approximately 2¼ cwt, and has a capacity of 8 cubic feet. The grader consists of a curved body plate with a silico-manganese cutting edge and two pivoting brackets. These brackets have been designed so that either of them can be attached in the fore or aft position on the side plates of the earth scoop. There are thus four positions given: two angular, with either end of the blade leading, and two transverse—that is, with the blade set straight across at right angles to the direction of travel—in which case it can be attached in either the forward or rear position. The makers say that the combined weight of an empty earth scoop and grader is often sufficient for satsfactory operation, but greater penetration can be obtained by loading with ballast up to 600 lb. When grading a road, as shown in the illustration, the leading end of the blade is set lower than the trailing end, by a levelling screw on the hydraulic linkage, so that the earth is excavated from the side of the road upwards to form the crown.

On several of the stands at Earls Court there were seen examples of recent developments in spraying equipment. One item of such equipment, shown by Kent Engineering and Foundry, Ltd., Tovil, Maidstone, Kent, is the "Mistblower," which is illustrated in Fig. 15.

It is a light machine for the low volume spraying of all kinds of crops and has been designed principally for work overseas on rough terrain, where it can be carried by men or transported on a jeep or similar vehicle. The makers say that originally the machine was produced for combating locusts, being used from the back of a truck for drift spraying, or being carried to deal with localised concentrations of locusts on trees. The "Mistblower" comprises a J.A.P. engine, running at 2400 r.p.m., which drives a Keith Blackman 10in blower requiring about 1·2 h.p. for a speed of 7600 r.p.m. The blower produces 120 cubic feet of air per minute through a 1in diameter nozzle at about 240 m.p.h. That velocity is required by the "Kiekens-Dekker" spray nozzle, which has a ¼in orifice. The ¾in gear pump for the outfit is directly driven from the engine by Dunlop flexible couplings through a Radicon reduction box. The liquid can either be drawn from a 6-gallon storage tank or direct from the concentration

barrel. A needle valve controls the quantity of liquid fed to the spray nozzle, which is placed at the outlet of a 2in swept bend. This bend can be moved through 180 deg. and locked in any position. The whole machine, which is 3ft long, 2ft 3in wide and 2ft 2in high and weighs 235 lb, is mounted on a litter having provision for carrying poles, the handles telescoping into the base when the unit is mounted on a truck.

Another of the firms exhibiting spraying equipment was W. Weeks and Son, Ltd., Perseverance Iron Works, Maidstone, on whose stand there was shown the "Plantector" low volume sprayer, illustrated in Fig. 13. It has been designed especially for the application of the hormone selective weedkillers, and rates of application on the standard machine are said to vary between 6 and 16 gallons an acre over a pressure range of 30 lb to 70 lb per square inch. The sprayer illustrated can be supplied for mounting on the hydraulic lift of the Fordson, Ferguson or David Brown "Cropmaster" tractors, or for direct mounting on tractors having no power lift. The raising and lowering of either of the boom arms can be carried out independently of each other, and to avoid nozzle drip an anti-drip device has been incorporated which in effect sucks the surplus spray liquid from the pipe system back into the tank. The tank is of all-welded steel construction, with a capacity of 40 gallons, and is fitted with a strainer basket and leakproof cover. The 18ft long spray boom is built in two sections and is spring loaded to permit horizontal movement should an obstruction be encountered. The boom carries twelve ceramic tipped spray nozzles. The pump is a bronze rotary gear unit with an adjustable relief valve. It is fitted with a flexible rubber coupling and is driven direct from the tractor power take-off shaft.

The exhibits of Pest Control, Ltd., Harston, Cambridge, included some sprayers fitted with the "Nodrif" boom, which the firm has designed to prevent damage from spray drift to neighbouring crops or livestock. This apparatus, which was described in our issue of April 13, 1951, consists of two light metal plates hinged in such a way that when arranged to form a cover to the boom their top extremities roughly seal off the entrance of air at the top. The plates extend at an angle of approximately 60 deg. to the vertical to form a triangular space, with the crop as the base and the spray nozzles as the apex of the triangle. A curtain of rubber strips hangs down from the extremities of the metal sheets, the tips of the rubber just wiping the crop and helping to seal the enclosed air.

An item of new equipment shown by the firm was the "Pestatom," a machine which has been designed for spraying, dusting and "wet dusting" in the application of insecticides. The term "wet dusting" implies the suitable addition of water to dust, a process which not only helps to weight the dust particles to prevent unnecessary drift, but adds also to the adhesive quality of the dust. The "Pestatom" was originally built for overseas requirements, but it is now being used in this country in orchards and other areas through which it may be difficult to drive a tractor. It is a small machine driven by a four-cylinder water-cooled petrol engine rated at 1260 c.c., which is coupled to a fan having an air output of 10,000 cubic feet per minute with an air speed of 80 to 100 miles an hour. The dust is carried in a hopper which has an approximate capacity—according to the density of the dust being used—of 100 lb, the output being adjustable from 0 to 50 lb of dust a minute. A 50-gallon liquid tank is provided, and the liquid output can be varied between 0 and 5 gallons a minute. The dust flow into the air stream is controlled to ensure a uniform rate of application, and liquid is introduced into the air stream by a rotary pump which is driven from the engine by roller chain drives. The liquid passes through a nozzle on to a spinning disc, which is situated in the main outlet nozzle, an arrangement which has been

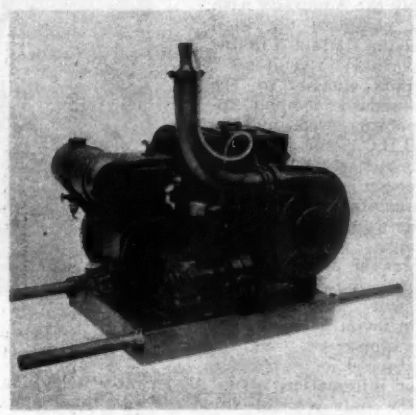


FIG. 15—"MISTBLOWER" SPRAYER—KENT ENGINEERING

adopted to assist the complete break-up and even distribution of the liquid. The main outlet barrel of the "Pestatom" can be moved vertically through 110 deg. and as the complete machine is mounted on a toothed circular base it can be rotated through 360 deg. by turning the operating handle. The machine can be transported either on a vehicle or a trailer chassis.

The machine illustrated by Fig. 16 is a rotary grass cutter which is manufactured by Hayters, Ltd., Spellbrook, Bishop's Stortford, Herts. It was designed originally for grass and weed cutting in orchards and similar places. Its cutting width is just over 6ft and the cutting height is adjustable up to 6in. This machine is now being built for operation by the Ferguson, Fordson "Major" and David Brown tractors. Power from the tractor is taken by the standard belt pulley attachment, a three-groove V-pulley being fitted instead of the usual flat pulley, and transmission is by belt to a ball-bearing countershaft running at 2000 r.p.m. This shaft is equipped with two pulleys to permit the cutter to be used either immediately behind the tractor or offset 22in. The drive is then taken by V-belt to each of three adjustable cutter heads. Each cutter head consists of a steel shaft to which there is fixed in a horizontal position a specially shaped "dural" plate having four cutter blades bolted to it. The rotation of the cutter heads can be quickly reversed by changing the direction of the belt drive. The machine is mounted on solid tyre rubber wheels with ball bearing castors. Recently, the makers of this machine have introduced a coupling to enable two cutters to work together, side by side, and thus give a cutting width of approximately 13ft. The coupling is a reinforced bracket which allows the independent vertical movement of each machine. The countershafts of the machines are connected by universal joints to the coupling shaft, and the drive from the tractor is taken by two five-groove pulleys instead of the normal three-groove pulleys. Towing lugs are attached to the side of one of the machines to enable their easy transport—as a combined implement—behind a tractor.

There was a representative selection of tillage implements shown at Earls Court last week, including the various versions of the Howard "Rotavator," made by Rotary Hoes, Ltd., East Horndon, Essex. A new version of this useful implement is a hand-controlled "Rotavator," which is powered by an air-cooled twin-cylinder, four-stroke engine of 810 cubic centimetres capacity. The engine has been built by Rotary Hoes, Ltd. The implement is provided with a 24in rotor, the depth of cultivation being adjustable in ¼in stages to a maximum in most soils of 9in.

Another exhibit was the heavy-duty "Rotavator," which the firm makes for the larger crawler tractors. A photograph of this implement attached to a heavy tractor is reproduced in Fig. 17. Its rotor is driven from the power take-off and, as the blades rotate in the direction of travel, there is created a forward thrust which assists the implement forward and lightens the draught on the tracks. Each blade of the "Rotavator" is a true hoe blade, designed to have a positive cutting and dividing effect on the soil. Transmission is through Renold chains which are hermetically sealed in dustproof cases and which run in oil. Two speeds are provided for the rotor carrying the blades, and a further change of gearing can be obtained by changing the sprocket on the intermediate shaft. Alternate rotor widths of 7ft or 8ft are available, the narrow width being generally considered the more suitable for working heavy soils. On the 8ft rotor the centre flange is removable allowing a gap to be left in the middle of the cut. The framework of the "Rotavator" is built entirely of fabricated steel and steel castings. The implement is provided with its own hydraulic lift and depth control winch.

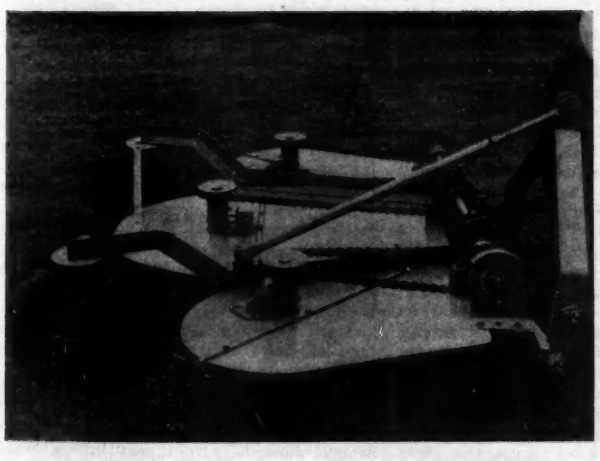


FIG. 16—ROTARY GRASS CUTTER—HAYTERS

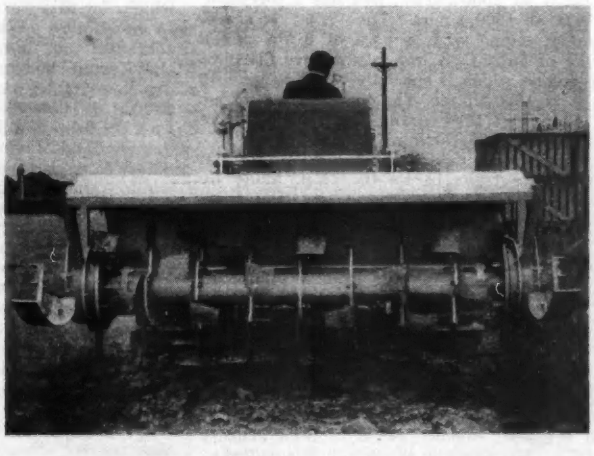


FIG. 17—HEAVY DUTY ROTAVATOR—ROTARY HOES

The different uses to which tractor operated hoisting equipment can be put were demonstrated by Stanhay (Ashford), Ltd., Elwick Works, Ashford, Kent. This firm showed its standard hydraulic hoist adapted for ditch clearing, as illustrated in Fig. 18. The hoist has a jib which swivels through 170 deg. to either side of the tractor, and with a bucket grab attached to the jib by a long length of chain it is possible to get down to the bottom of a ditch to a depth of 11ft with the tractor standing approximately 2ft from the bank. As the jib can be swivelled to either side of the tractor, the spoil gathered by the grab can be deposited well clear of the ditch.

An event of considerable interest during the show was the open meeting arranged at Earls Court last Thursday afternoon by the Institution of British Agricultural Engineers, when, as reported in our last issue, a paper was presented

FIG. 18—HYDRAULIC HOIST—STANHAY

by Mr. C. W. Chapman, M.I.Mech.E., on "The Diesel Engine as Applied to Agriculture." On several stands at the exhibition there were to be seen diesel and other oil engines which are now available for agricultural work in particular. F. Perkins, Ltd., of Peterborough, exhibited a "P3" diesel conversion pack for Ferguson tractors, and a "P6" conversion pack for the Fordson "Major." Both these packs are now available for the home and export markets. The "P3" diesel engine, which the company introduced about a year ago, is a three-cylinder unit, having a bore of 3·5in and a stroke of 5in. Aluminium pistons are fitted and the engine is rated to develop 32 b.h.p. at 2000 r.p.m., and has a torque of 88 lb-ft at 1200 r.p.m. The "P6" is a six-cylinder engine with a bore of 3·5in and a stroke of 5in. Cast iron pistons are fitted to this engine which is specially rated to give 45 b.h.p. at 1500 r.p.m. The engine has a torque of 163 lb-ft at 1200 r.p.m. Both engines have push-button cold starting.

Other engines exhibited included petrol and diesel units from 1½ to 40 b.h.p. made by Petters, Ltd., Staines, Middlesex; the twin-cylinder diesel engines from 14 to 20 h.p. which are produced by Armstrong Siddeley Motors, Ltd., Coventry, and the two-stroke and four-stroke oil engines, ranging from ½ to 4 h.p., built by the Villiers Company, Ltd., Wolverhampton.

THE DOCKS AND INLAND WATERWAYS EXECUTIVE announces the appointment of Mr. G. D. Lloyd as civil engineer, Humber Ports, as from January 1, 1952. Mr. Lloyd is at present assistant chief engineer, Humber Ports.

Underwater Television

WE recently received brief particulars of the television equipment that was specially adapted for underwater work in the diving operations that culminated last May in discovering the position of H.M. submarine "Affray," lost on April 16th. It may be recalled that this occasion marked the first practical application of television under the sea.

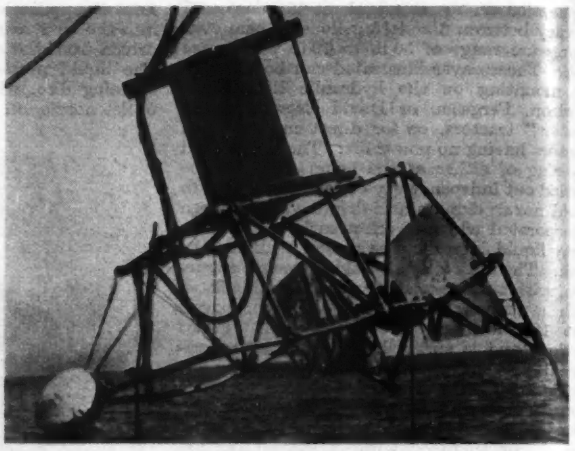
Some months before the loss of the "Affray" the characteristics of Marconi "Image Orthicon" television cameras had been demonstrated at the Admiralty Research Laboratories by Marconi's Wireless Telegraph Company, Ltd., of Chelmsford, Essex. As a result of these demonstrations the company was able, shortly after the "Affray" was reported missing, to supply the Admiralty with a complete television chain, contained in five portable "suitcase" units similar to the standard 405-line apparatus used by the B.B.C. for outside broadcasting. Work was begun at once on the manufacture of an underwater camera equipment, and, as speed was the first consideration, finish and refinement were ignored in favour of immediate performance. In the absence of experience or information about underwater television, the only available standards were those which had been obtained by the Admiralty in its study of television camera chains and its previously acquired knowledge of underwater cinematography.

No modifications were necessary on the electronics side of the camera or the tube circuits, but additional instrumentation was provided: it included remote operation of the camera heater and the cooling fan, a method of showing the temperature inside the camera, a remote level indicator and a water-leak detector. These precautions were essential to the success of the venture, since the proper functioning of the "Image Orthicon" tube depends on maintaining the correct operating temperature. The necessary cabling for this instrumentation was provided by the spare cores (which normally carry communication channels from the control positions to the camera operators) in the 32-core cable which was supplied by British Insulated Callender's Cables, Ltd. Apart from a special protective sheathing to make the cable suitable for use at a depth of several fathoms, it was of similar design to the cable used by the B.B.C. television service.

Only one lens was used—a 2in *f*1·29 lens, which, for this particular operation, was set at *f*4 on infinity. When the underwater camera container was first built the expectation was that it would be required to work at a maximum depth of 200ft; in practice it had to work at 280ft. As illustrated herewith, the container took the form of a welded steel cylinder, 17in in diameter and 24in long. The base of the cylinder, which formed a platform for the camera, lens window and cable gland, was made detachable. There was no time to design and prepare shock-absorbent mountings. The camera window was of ½in plate glass with a clear aperture of 3in. Lighting was provided by a 1¼kW tungsten filament divers' lamp, which was fitted into the tubular framework and suitably shielded to prevent direct illumination from reaching the camera lens. Apart from the main purpose of the tubular framework, which was to accommodate the lighting fitting, it helped to give some protection to the camera.

Less than three weeks after the delivery of the camera the completed apparatus was installed in H.M.S. "Reclaim," the Admiralty diving ship. Waveform generators, camera control equipment and monitors were installed in the captain's cabin and were connected to the camera by 500ft of multi-core cable. In addition to the normal camera monitor, a main viewing screen was provided by an English Electric domestic television receiver which had been adapted to receive signals direct from the line. When she sailed on May 27th the "Reclaim" was the first ship to be equipped for underwater televising.

Handling the underwater camera proved to be simpler than had been expected. It was



UNDERWATER TELEVISION RIG

suspended, hanging lens downwards, by a non-spin wire from a derrick mounted on the well deck; the multi-core cable was handled separately. To move the camera to any required position the ship was shifted by altering the mooring cables. Under the prevailing conditions 280ft below the sea the camera's range proved to be not less than 15ft, compared with the direct visual range of 5ft as reported by divers. An even greater advantage was that the camera could be used continuously under water for two hours or more, whereas a diver at the same depth could work only for a few minutes at a time.

The Report of the Gas Council

THE second annual report of the Gas Council for the year ended March 31, 1951, has just been issued, together with the reports of the twelve area boards. It states that the year under review was not an easy one, for the area boards had to meet increasing demands for gas with stocks of coal which were constantly the cause of great anxiety. Delays in the delivery of steel and other materials also added to troubles, in that the completion of sorely needed plant has been badly retarded. At the same time, steady improvement was made both in the efficiency of gas manufacture and the standard of service given to consumers. It is pointed out that whilst major economies must await the fulfilment of their long-term plans, the area boards show in their reports that substantial administrative economies have been made in a number of instances against a background of increasing costs of materials and services. The organisational problems of the first formative period having been passed, it is considered that the boards have been able during this second year to see their objectives in clearer definition and make good headway in planning for the attainment of their aims.

During the year under review sales of gas totalled 2460 million therms, an increase of 5 per cent on the previous twelve months. The number of consumers was 11,981,000, an increase of 120,000 for the year. In this second year of nationalisation nine of the twelve area boards showed a surplus and three a loss on the year's working, the net surplus of the industry

amounted to £1,492,784. The gross revenue was £233·5 million, which included £133·3 million from the sale of gas, £63·2 million from the disposal of by-products, £23·4 million from the sale and hire of appliances, £8 million from rentals, and £5·6 million from other sources. Gas purchased and produced cost £133·8 million, of which £98·4 million represented the cost of raw materials, including £86·3 million for coal. The average income per therm of gas sold was 13d., that for domestic use being 14·8d., industry 9·51d., commerce 13·18d., public administration 12·01d. and lighting 8·81d.

Some 26,368,700 tons of coal were carbonised by the gas industry during the year and the production of coke and breeze was 11,847,000 tons and 2,719,700 tons respectively.

Dealing with the manufacture and distribution of gas, the report points out that the demand for gas, particularly by industry, is constantly increasing, and unless area boards can obtain the new plant they require supplies of gas will be in danger. At present some boards cannot accept important industrial loads until new plant is brought into use. The ability of the gas industry to play its full part in industrial productivity will depend upon its receiving an adequate allocation of the capital expenditure programme and supplies of steel, coal and labour. Extensive use is being made of water gas manufacture to make use of all available plant, and the use of coke for this purpose has had its effect on the coke market. In many parts of the country progress has been made with the interconnection and integration of gas supply for gas grids, despite delays in the delivery of materials. Since the vesting date production has ceased at fifty small gasworks and the local requirements supplied from larger stations.

In order to draw up programmes of research and review progress from time to time, a research committee has been formed by the Gas Council and two research stations have been set up. A complete survey of research in progress has been made, the report states, and a comprehensive programme based upon the report has been drawn up and approved. Amongst the important items of research approved are investigations into the complete gasification of coal, the gasification of fuel oil, the recovery of sulphur and the disposal of liquor effluents.

Water Supply at Glasgow

THE Glasgow Corporation Water Department has recently put forward proposals for increasing the city's supply of water. As is well known, the source of Glasgow's water is Loch Katrine, but it has now been proposed that additional water should be obtained by constructing an intake weir, tunnel and ancillary works at Glenfinlas, a valley adjoining the Loch Katrine catchment area to the east and lying to the north of Brig O'Turk village. The Finlas Water at present discharges into Loch Vennachar, one of a chain of lochs at the head of the River Teith. Loch Vennachar is not used by the corporation to provide water for the city, but maintains the amount of compensation water which must be passed from the River Teith into the River Forth, in accordance with agreements made when the Loch Katrine scheme was constructed under the Act of 1855.

The development of the Glenfinlas catchment area as an additional source of supply was first proposed in 1915, but the present scheme is a considerable modification of the original one. Instead of constructing a large impounding reservoir at considerable capital cost, a small intake weir will first be built, together with a tunnel of about 8ft in diameter and approximately 2¼ miles in length, which will serve to divert a large portion of the flow of Glenfinlas water into Loch Katrine, where it will be stored until required. By this means the estimated cost of the project has been reduced from over £2,000,000 to approximately £600,000. Although the present scheme will not yield as much water as would be available from the impounding reservoir originally proposed a sufficient margin of safety will be provided for the present needs and rising consumption of the city. The works now proposed will be designed in such a manner as to allow the construction of the impounding reservoir at a later date should the necessity arise. Work on the new project will be commenced as soon as the necessary authority is obtained.

A second decision taken by the water committee dealt with the route of the 36in diameter west main, which is at present under construction and which, when completed, will run from the service reservoirs at Milngavie through Knightswood, Scotstoun and Shieldhall to Crookston (see THE ENGINEER, April 28th 1950). The main will cross the River Clyde by tunnel, the proposed tunnel being about 250 yards east of King George V Dock.

When the west main was originally planned in 1948 it had been intended to carry the water main through the Whiteinch/Linthouse vehicular tunnel, which was to be constructed at an early date. This vehicular tunnel was, however, delayed at the request of the Ministry of Transport and as it is still uncertain when construction will be commenced, the water committee was unable to accept the delay, in view of the needs of the city for additional supplies of water, particularly in the south-western areas.

It was accordingly decided to construct a separate tunnel for carrying the water main across the River Clyde. This tunnel will be 12ft in diameter with shafts of 18ft in diameter at each end, reaching a depth of 99ft and 85ft, respectively. A second 36in diameter main can therefore be accommodated should it be required in the future. Owing to the nature of the ground it will be necessary to use compressed air in the sinking of the shafts and for at least part of the tunnel work. The shafts and tunnel will be lined with cast iron segments. It is hoped to complete the tunnel in approximately two years after commencement of the work early next year, and in the meantime arrangements are being made to proceed with the laying of the water main up to the approaches of the tunnel on each side of the river. The estimated cost of the west main works, about half of which are already under construction, is now approximately £1,000,000, which includes the cost of construction of the tunnel works.

In addition to proceeding with the preliminary work for the two major projects described above, the water department is arranging to construct an additional line of siphon pipes in connection with the Loch Katrine to Milngavie aqueducts. This work, estimated to cost over £250,000 will commence in the spring of 1952 and be completed some two years later. The present general manager of the water department is the engineer for all the above new works with the exception of the tunnel under the River Clyde, for which the consulting engineers are Messrs. Mott, Hay, and Anderson.

Chemical Engineering Research Facilities

THE committee appointed by the advisory council of the Department of Scientific and Industrial Research to review the needs for research in chemical engineering has issued a report, published by H.M. Stationery Office (price 1s. 6d.). The committee, which consists of ten members, with Mr. H. W. Cremer, C.B.E., as chairman, and represents industrial and university interests, states that research needs are of two kinds. One relates to the fundamental operations in industry such as drying, filtering and evaporating, the other to acquiring data, based on the functional analysis of large-scale operations. The first of these needs can be met by developing facilities already in existence but facilities for meeting the second are inadequate.

Striking examples can be given, says the report, of manufacturing operations originating in this country being left to other countries to develop or modernise. The result is that they are sometimes used here under foreign licences or operated in plant purchased from abroad or constructed to foreign designs. Frequent comments were made to the committee on the delay in using new discoveries by our own scientists.

The committee expresses the opinion that the national requirements for research can only be met if the existing facilities are supplemented by a central organisation, as existing research stations or industrial research associations would not meet the case. The normal sectional interests of these bodies would not permit the high priority which is deemed necessary for the problems in mind.

Locomotive Inspection Pit Lighting

IN applying the advantages of fluorescent lighting in locomotive inspection pits, one of the difficulties is the protection of lighting fittings from oil and water dripping down the side walls of the pits, without interfering with the light thrown upwards to the underside of the locomotives, to provide adequate illumination for oiling and greasing of essential parts. An installation of pit lighting recently completed at the Beckton gasworks of the North Thames Gas Board demonstrates a method of overcoming these difficulties by the use of fittings

LOCOMOTIVE INSPECTION PIT LIGHTING AT BECKTON GASWORKS

specially designed for such applications by the General Electric Company, Ltd. The gasworks, it will be appreciated, has its own internal railway system of about 100 track-miles and forty steam locomotives.

Two pits in a running shed where locomotives are inspected and oiled up by their crews before beginning their daily duties have each been equipped with eight of these fittings, arranged in pairs in the opposite walls in the four sections of the pits where most of the work is carried on. As illustrated above, the fittings have inclined front glasses and polished aluminium angle reflectors for directing the light upwards into the mechanism. They are recessed behind the face of the side walls, and a groove is arranged in the upper part of each concrete enclosure, so that the front glasses are protected from oil and water dripping from the locomotives. The armour plate front glass is attached to the heavy gauge steel body of the fitting by twelve bolts, and the joint is sealed by a rubber gasket to exclude oil and water. Each fitting accommodates one 5ft, 80W lamp.

We learn that since this pit lighting was installed it has been unnecessary for the crews to use hand lamps when oiling up their locomotives. The work of daily inspections is simplified by the level of illumination on the motion and other parts right up to the underside of the boiler, and the freedom from shadow achieved by using an elongated light source.

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POWER FOR THE PLOUGH

IT has been stated that the Smithfield Show and Agricultural Machinery Exhibition at Earls Court last week was visited by over 66,000 people, the largest number in any year since 1903. The nature of this exhibition has certainly changed. No longer is there a preponderance of cattle, though the quality of that shown is as good as ever. By far the greater part of Earls Court—which has become the home of the post-war "Smithfield"—is occupied by farm machinery and implements. This year, in fact, the quantity seemed to be greater than ever, and the numerous visitors, both from home and overseas, were obviously anxious to give as much, if not more, attention to the machinery stands as to the excellent contents of the cattle pens. With the growth of populations, intensified agricultural production is assuming ever-increasing importance, and it is now being appreciated more and more that, to bring about an increased agricultural output, mechanical power is essential for amplifying the work of man. How much the use of mechanical power on the land has advanced in recent years was again demonstrated by the vast array of tractors and implements shown at Earls Court last week. But it was an array which also emphasised that the greater utilisation of mechanical power on the land has been effected by the progressive development of the internal combustion engine.

This last point was dealt with in a paper entitled "The Diesel Engine as Applied to Agriculture," which was presented by Mr. C. W. Chapman, M.I.Mech.E., at a meeting of the Institution of British Agricultural Engineers at Earls Court last Thursday afternoon. The interest in the subject can be gauged by the fact that the hall reserved for the occasion proved to be too small, and for many members of Mr. Chapman's attentive audience there was "standing room" only! Mr. Chapman pointed out that, as on the modern farm mechanisation is now being applied to almost every task, an increasing consumption of power is called for. The bulk of that power, of course, must be produced on the site of operations, and the paper referred to the requirement for suitable prime movers ranging from around 1 h.p. for driving barn machinery to upwards of 100 h.p. for large tractors. Some of these prime movers must be of the stationary or semi-portable kind, and others must be traction units. But all of them, Mr. Chapman emphasised, need to be reliable, economical and easy to maintain under the arduous conditions on the land. Herein, we suggest, is a clear indication of what the farmer demands as he proceeds with the fuller mechanisation of his industry, and of what the engineer must use every endeavour to supply. In agricultural mechanisation especially, the best yardstick for measuring progress is to look back along the road that has been travelled. The day seems far distant now when, according to J. A. Scott Watson's excellent *History of the Royal Agricultural Society*, a farmer at Cricklade worked 800 acres with fifty-six oxen and a few horses, seven four-ox teams providing the power for the morning shift and seven more for the afternoon. It is unlikely, however, that with one such team as the prime mover, controlled by a man and a boy, any more than an acre a day could be ploughed! Furthermore, the care and maintenance of oxen and horses were undoubtedly more complicated and more expensive in man-hours than are the care and maintenance of prime movers on the farm to-day! It is interesting, too, to note that this same farmer, soon after the middle of last century, acquired a set of 14 h.p. steam tackle, the purchase price of which was largely met by the sale of the oxen. Steam tillage had its day. It was an era of mechanised farming to which the engineer made an important contribution. But steam tackle was a useful supplement to the horse and no substitute for it. Steam traction engines at work demanded, amongst other things, a continuous supply of coal and water, the transport of which was a full-time job for horses and men. More than a generation had to pass before a lighter and handier power unit in the form of the internal combustion engine proved itself acceptable to the farmer and came to be recognised as something more than a substitute for the horse. Yet the result of that recognition is that this country now occupies a leading position in mechanised agriculture. It is a position which has not been reached without many a headache and heartache for engineers and farmers, but it is one of which they may be justly proud.

To-day, according to Sir James Turner, the president of the National Farmers' Union, there are more than 360,000 tractors in use on British farms, not to mention stationary and semi-portable oil engines of the kind referred to in Mr. Chapman's paper. Many of them are in the petrol-paraffin class, many are vapourising oil units, and an increasing number are diesel engines. A question that is now being often asked by farmers and agricultural engineers alike is "Where do we go from here?" Mr. Chapman presented a strong case for the diesel engine by saying that "the efficiency of an internal combustion engine increases rapidly with higher compression ratios so that the diesel is much more economical than the spark ignition engine, and its fuel is also cheaper." He acknowledged that the diesel engine was more expensive in first cost and that the price of the injection equipment particularly made it uncompetitive in the lower power ranges. He observed also that there was a place on the farms for more diesel engines of lower horsepowers. But, in his conclusions, Mr. Chapman made one point which deserves special consideration. He urged that simplicity should be the keynote of the design of an agricultural engine, and that reliability, fuel adaptability and ease of maintenance should have precedence over absolute fuel economy. We know that agricultural engineers and those engaged in the internal combustion engine industry are not unmindful of these matters. Among all the reasons advanced in the paper in support of the wider application of the diesel engine to agricultural work, these are possibly the ones which merit the most attention.

THE DEFENCE DEBATE

IN his frank and wide survey of our defence position last week, the Prime Minister set the tone for a debate which throughout was almost entirely devoid of party politics. Before dealing with the more controversial subjects, Mr. Churchill made a reference to the current problems of the three Fighting Services and promised that, given reasonable time, the new Government would do its best to ensure the most efficient and economical organisation of our forces He mentioned as an example the £7 million a year spent on what may be called the "pipeline" of our communications—30,000 of the 450,000 men now in the Army awaiting orders to move to and fro—an expense partly due to the necessity for sending National Service men to the Far and Middle East. Even three years' service in the Regular Army would help matters considerably and a scheme to achieve this has recently been introduced under which conscripts are encouraged to volunteer for another year and thus have the benefit of

the higher Regular rate of pay. The Prime Minister made only the barest reference to the Senior Service, presumably because he is satisfied for the time being with the substantial building and conversion programme now under way of well over 100 fast anti-submarine vessels and minesweepers. The Navy, he said, had played its full part with distinction in the present difficult circumstances of the cold war, whether in Korea, Malaya or the Middle East, but he seemed far from pleased that there were now some 10,000 civilians and 650 officers in the Admiralty departments as compared with 4000 in 1938, when the Navy was much larger, though less complicated.

Mr. Churchill considered that the greatest cause for concern was the slow progress made in the supply of the latest machines for the Royal Air Force, particularly in view of the £300 million we are spending this year on re-equipping, and because of the formidable quality of the Soviet jet fighters. In a characteristic phrase he suggested that the whole system of supply and production is suffering from acute indigestion and admitted that Mr. Aneurin Bevan happened—apparently by accident—to have been right in his forecast that we could not spend the £1250 million allocated for this year of the £4700 million rearmament programme. These points were taken up and elaborated in the subsequent debate by back-benchers on both sides of the House. Mr. Orr Ewing maintained that too much effort was being diverted to too perfect and unnecessarily attractive-looking equipment. "Why," he asked, "must all equipment be capable of operating from the Arctic to the Equator when this adds one-third to its cost and a third of the time that would otherwise have been necessary to develop it?" The Member for Hendon North, however, cannot be fully conversant with operational requirements and he would have been on more solid ground if he had pressed for leading industrialists to attend a course at the Imperial Defence College, where all aspects of Imperial Defence and strategy are studied by senior officers from the Fighting and Civil Services of this country and the Dominions. Mr. Mikardo argued that we had not received much more than one-quarter of the machine tools due to date from America and that this, combined with the hold-ups in material and the shortages and immobility of labour, would prevent us completing the programme planned for three years in less than five. Much of what the Prime Minister had to say had little direct interest for engineers. But indirectly the work of engineers is likely to be influenced by, for instance, decisions about the role of the British Army in Europe. The Prime Minister informed the House that Dr. Adenauer had reaffirmed Germany's willingness to join a European army and his dislike of a national army. Mr. Churchill emphasised that this was the policy he had always advocated. "Britain," he added, "with her forces now in Germany, is already joined to the European army, though we do not propose to merge in it." Mr. Churchill then referred to the policy of stationing United States bombers in East Anglia—a policy we had all supported—and to the Russian view that they were intended to drop atom bombs on Russia. We must face the fact that this placed Britain in the front line in the event of a third world war. In his view we must be prepared for paratroopers and for this reason the Government proposed not only to recreate the Home Guard but also the Royal Naval mine-watching organisation—a Corps which did valuable service in the last war in locating mine-dropping aircraft and mines. The Government also intended strengthening the Royal Observer Corps and arming the regular military establishments throughout the country for self-defence.

Dealing with the new 0·280 rifle, the Prime Minister considered that on present plans for the retooling of factories we should be able to begin production in 1953, and be producing at the rate of 100,000 a year by the end of 1954. But we required a pool of some three or four million rifles and we had less than two and a half million available now. He did not propose going ahead with retooling for the 0·280 until further discussions had been held and a harmonious long-term policy had been evolved. Finally, before concluding with a reference to our present commitments in Korea, Malaya and Egypt, Mr. Churchill turned to the question of the Atlantic Command. He was still not convinced of the need for a supreme commander, but, given the need, the nationality of the commander was a secondary consideration—a statement which drew from the Opposition a charge of inconsistency. It was essential, he continued, that the British Admiralty should have complete control and direction of the reception area of transatlantic convoys. All the rest of the problem could be solved, but conflict or duality of control between a supreme commander and the Admiralty might well be very injurious. The Admiralty and the United States and Canadian naval chiefs should work together as they always did, any questions of transfer of forces being settled when necessary, as they were before, at a higher level. He did not like the definition of coastal waters around Britain and suggested the 100-fathom line should be examined as an alternative. Nor could there by any question of treating the Bay of Biscay differently from any other part of the approaches to this island for Western Europe. He felt, however, that the problem could be solved by further friendly discussion and thus enable us to do the work, for which we have unqualified experience and expert knowledge, of bringing safely into the western shores the aid and supplies that come from across the Atlantic Ocean. Our readers will remember that this journal has consistently supported Mr. Churchill's views on the Atlantic Command.

Obituary

ADOLF VINES

We regret to record that Mr. A. Vines, who was a founder and chairman of Evershed and Vignoles, Ltd., died, in his eighty-fifth year, on December 1st at his home in Richmond.

Mr. Vines was educated at Emanuel College, Cambridge, from 1886 to 1890, and took the Natural Science Tripos Parts I and II. He joined Evershed and Vignoles, Ltd., as works manager, when the company was formed in 1895. The firm began in a modest way with a total staff of eight, but Mr. Vines lived to see the enterprise grow into a manufacturer of electrical instruments with more than 1300 employees on its payroll. From 1909 till 1940 he was a joint managing director of the company. When he retired in 1940 he retained his seat on the board of directors and in August, 1940, he was elected chairman, a position he held until his death.

Mr. Vines had a number of interests outside the firm whose fortunes he shared throughout his career. Until three weeks before his death he was a member of the management board and conference committee of the Engineering and Allied Employers National Federation. He had been a vice-president of the British Engineers Association, vice-chairman of the British Scientific Instrument Research Association and chairman of the Economic League, London and South Counties. His association with the Institution of Electrical Engineers goes back to 1891, when he was elected an Associate; three years later he was made a full member.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

ASSESSMENT OF LOCOMOTIVE PERFORMANCE

Sir,—Correspondence upon the above subject seems to have centred upon the running of the down "Coronation" express between King's Cross and York. In general I would agree that the "A4" engines had the job comfortably in hand. With strict observation of the various service slacks the timing could be maintained without exceeding 85 m.p.h. on level track, though on favourable stretches speeds of 95 m.p.h. and more were regularly run. The biggest effort was usually made between Peterborough and Stoke Summit, where I once observed No. 4490 "Empire of India" to cover the 20·6 miles from Werrington Junction up to Stoke signalbox at an average speed of 79·9 m.p.h., including a sustained minimum speed of 76 m.p.h. on the 1 in 200 gradient, 4½ miles long between posts 91 and 95½. This was with the full summer load of 312 tons tare, and involved a drawbar horsepower (corrected for gradient) of some 1700.

I would certainly not agree that 90 m.p.h. on the level represented the limit of the "A4" engines with this train. I have a record with engine No. 4491, on the southbound train, also with 312 tons, when a speed of 95 m.p.h. was sustained absolutely for a stretch of 4 level miles. I had no footplate experience with this train, but with fifteen-coach trains of standard L.N.E.R. corridor stock, approximately 475 tons tare, the "A4" engines would settle down to a steady 75 m.p.h. on level track with the reverser in its normal running position, 15 per cent cut-off. They can still do it.

The trouble with the "Coronation," that led occasionally to loss of time in both directions of running, was that the one engine ran through from London to Edinburgh, and that on a rough trip shortage of coal might develop towards the end of the run. The tenders carry 9 tons, and this would allow a maximum consumption of 75 lb to 80 lb per square foot of grate area per hour. Even with such economical engines as the "A4's" this would not leave too big a margin, and cases did occur when the southbound train ran short of coal and had to stop at Hitchin. With the original "Silver Jubilee" train, of 220 tons tare, Sir Nigel Gresley stated that the average drawbar horsepower required on the run from London to Newcastle was 620. The "Coronation" was timed at almost exactly the same speed, and with 312 tons one could expect the drawbar horsepower required to be

some 850 to 900. Taking the former figure and an overall engine performance of 3 lb of coal per d.h.p.-hour would mean a total consumption of 7 tons. Rough weather might easily bring the d.h.p. required up to 950 or even 1000; and if, with an engine nearing the time for general overhaul, coal consumption rose to 3·4 lb to 3·5 lb per d.h.p.-hour there would be no margin at all. Changing engines at Newcastle, as with most other Anglo-Scottish expresses, would have made all the difference.

O. S. NOCK

20, Sion Hill, Bath,
December 4th.

THE REQUIREMENTS OF A GOOD TOLERANCE SYSTEM

SIR,—I fully endorse Mr. H. G. Conway's arguments in his article (THE ENGINEER, July 20, 1951), entitled "The Requirements of a Good Tolerance System," wherein it has been admitted that the B.S. system is "obsolete," and I am also fully convinced that the I.S.A. system would not only replace the B.S.S. in U.K., but also be universally adopted all over the world in view of the present day necessity for an international collaboration and a universal system of interchangeability.

When this project was embarked upon we had either to adopt the B.S. system of tolerances or the I.S.A. system. While in this country the inch and B.S.S. are extensively used our first choice was naturally towards the B.S. system, but when we were unable to accommodate the required ball bearing fits we had either to use the B.S.S. for general purposes and standardise separate fits for the ball bearings or to choose a new system altogether. This naturally led us to the adoption of the I.S.A. tolerance system, which has been tried and tested on the Continent, after converting it into inches by obtaining the basic tolerances from a developed formula. One could be easily convinced about the easy adaptability of the I.S.A. system in the matter of changing over from the Hole Basic System to the Shaft Basis, which is normally used in obtaining the desired ball bearing fits.

A fundamental advantage obtained in the I.S.A. system with the various standard holes, H6, H7 and H8, by having a clear picture of the fit (since all the H quality tolerances are always unilateral and one could easily visualise the fit), is not obtained by using fits with the bilateral holes X in the B.S. system. This disadvantage is somewhat rectified by using the unilateral hole U of the B.S. system. The stepping of tolerances under qualities B, U, V, W, &c., for a diameter range in the ratio 1, 2, 4, 8, &c., is really coarse, and the present nominal sizes are not even under the preferred series, which is the modern practice.

While I agree with Mr. Conway's remarks that the word "allowance" under the B.S.S. is misleading and that it does not include the case of oversize shafts, I would expect the mean value to occur more frequently than the minimum value of the tolerance zone. According to the well-known Gauss'sche's law it is the mean value that is normally considered in the majority of cases.

On page 79, under paragraph 3, while agreeing that there are no serious defects in the I.S.A. system, Mr. Conway remarks that there is in some quarters a feeling for the necessity of an additional intermediate fit between g6 and e8 over the one already provided. The clearance fits illustrated in Fig. 3 are some of the preferred fits that are normally adopted and there is no restriction whatsoever on choosing one of the more unusual fits to fill up this gap, if one so desires, as Mr. Conway himself admits in the succeeding paragraph. Further, the illustration itself for the fits Hole H8 and Shafts e8 and f7 for a diameter range 2in to 3·15in is rather misleading since the lower limit of f7 and the upper limit of the tolerance zone e8, which is −0·00236in, have been misrepresented and if this value is correctly plotted and the mean values considered for the three tolerance zones the picture would not appear to be as coarse as was represented. Mr. Conway's article, anyway, deserves serious consideration and contains valuable suggestions, and it is hoped that the opposition to adopt a tolerance system that emanated outside a country would get reconciled to his views as was the case on the Continent, where, in spite of individual national tolerance systems, the I.S.A. system got established.

R. KOBAN

Ambarnath, India, December 4th.

Dollar Exports Council

THE formation of a new Dollar Exports Council has been announced this week. Prominent British industrialists with wide experience of the North American markets have joined the council and it has been agreed with the Government that high officials of the Treasury, Board of Trade and Ministry of Supply will hold themselves in readiness to join in the discussions of the council in all matters where Government policy is involved. To ensure co-ordination of policy and effort on both sides of the Atlantic leading businessmen in Canada and the U.S.A. have been appointed as overseas members of the council. For the direction of the day-to-day work in this country a new executive committee has been formed and immediate steps are being taken to appoint a whole-time chief executive. When the former Dollar Exports Board was wound up last June, it was succeeded by a body—the Dollar Exports Advisory Council—with advisory powers only. Since then the worsening of the dollar situation has made it imperative that an organisation of much wider scope should be established, which could go out to industry and take positive steps to assist and encourage individual firms and industries in their dollar sales problems. The new body has been formed by industry and is sponsored by the national industrial commercial and financial organisations. It has the full support of the Government. Sir William Rootes is the chairman of the council, the offices of which are at 41, Buckingham Palace Road, London, S.W.1.

Building Research in 1950

THE annual report of the Building Research Board of the D.S.I.R. for the year 1950 has just been published. During that year the board was concerned with investigating the possibilities of making much more use of mechanisation, new techniques and new materials in the building industry. A special study was made of building costs and the factors that influence them, and a survey was completed during which local authorities and private firms made available for analysis the records of costs and labour for 200 contracts. The data collected are being used to prepare standards of comparison for the use of the industry. During the year the responsibility for economic and sociological research on building was transferred from the Ministry of Works to the D.S.I.R. This work includes the study of building methods and the consideration of problems concerning the specialised needs of various users besides that on cost analysis. An improved method of construction of composite slab and girder bridge decks was evolved at the Building Research Station. The method uses inverted T-steel girders and precast concrete slab elements designed to replace the top flange and to act in structural combination with the girders. A method of analysing the elastic stresses in concrete shell roofs has been found which removes many of the uncertainties of other methods of design. Selected typical cases have been worked out in detail and the results verified by means of small-scale plastic models. Work on soil mechanics has included investigations in the laboratory of physical and mechanical properties of soils in order to obtain more information to apply to problems in the field. The distribution of the bearing capacity of piles between skin friction and point resistance has been studied, and it was found that in granular sands skin friction is small, but in cohesive soils it is the major component and point resistance is small. New information about the mechanics of failure in soil subjected to seepage has been obtained by electrical analogy studies and model tests in a seepage tank. The tests showed that thin horizontal layers of gravel, fine sand or silt can help to bring about failure in a cofferdam. Mechanical aids to building have been studied and the work included the study of the behaviour of machines on site, and collaboration with manufacturers in the development and testing of suitable plant. The machines considered include long-reach tower cranes for handling materials, powered vehicles for carrying concrete, mortar mixers, building jigs and a transporter boom for concrete. Study of prefabrication has included not only problems concerned with the application of this technique to the shells of buildings, but to those met in applying the principle to the production of internal fittings needed to complete the building. Among subjects bearing on the efficiency of buildings which have been studied are lighting and glare, colour schemes, working temperatures, ventilation, sound insulation and plumbing.

The British Contribution to Television

THE Institution of Electrical Engineers has issued further particulars of the convention on "The British Contribution to Television," which is to be held in London from April 28 till May 3, 1952. It is expected that between sixty and eighty papers will be presented for discussion, and many of these papers have already been submitted. Advance copies in proof form of all papers will be available in April next, and they will generally be supplied in sets, each set comprising the papers allocated to a particular session. After the convention, four issues of the *Proceedings of the Institution* are to be published containing the proceedings of the convention, including addresses and the full text of all the papers with discussions and authors' replies. During the technical sessions, which will cover all aspects of television from the programme production to the viewer, there will be interesting demonstrations of television equipment, including large screen projection television and, it is hoped, an early Baird thirty-line equipment. Visits of inspection during the convention, which will be open to registered members and their ladies, will include B.B.C. television studios and the latest television transmitters, the Post Office Research Station, the terminal equipment of the London–Birmingham coaxial link cable, and certain commercial organisations. The sessions into which the convention will be divided are as follows:—Historical, programme organisation, point-to-point transmission, broadcasting stations, propagation, receiving equipment, non-broadcasting applications and system aspects. Copies of the convention programme and combined registration and order form will be available shortly and will be sent to those who have asked for details. Anyone who has not yet applied and requires details should apply to the secretary of the Institution of Electrical Engineers.

THE LATE MR. B. M. JENKIN.—We have learned with regret of the death of Mr. Bernard Maxwell Jenkin, which occurred on December 3rd. Mr. Jenkin, who was born in 1867, was the youngest son of Professor Fleeming Jenkin, of the University of Edinburgh. He was trained as an electrical engineer on the London and North-Western Railway, and subsequently joined Sir Alexander Kennedy in a consulting practice under the style of Kennedy and Jenkin, a firm which continues to practise as Kennedy and Donkin. Mr. Jenkin retired in 1913, and took up farming on scientific lines.

The Iron and Steel Institute

No. III—*(Continued from page 726, December 7th)*

ON the afternoon of Wednesday, November 21st, there was a discussion of the following papers :—

SYMPOSIUM OF PAPERS ON STRESSES IN MOULDS

Conclusions

The main conclusions reached in each paper of this symposium can be summaried as follows :—

(1) Examination of the mechanical properties of ingot mould irons has shown that :

(*a*) The ultimate tensile strength varies between 5 and 10 tons per square inch at room temperature and it does not fall with increasing temperature until above 400 deg. Cent.

(*b*) Under repeated loading conditions, a load equivalent to 80 per cent of ultimate tensile strength can cause failure of a specimen after 80 cycles.

(2) The values obtained for Poisson's ratio on a number of ingot mould irons at three temperatures are much lower than those generally assigned to cast irons.

(3) Relaxation of stress in ingot mould irons is exceedingly rapid at temperatures of approximately 700 deg. Cent. and probably at temperatures of 600 deg. Cent. and above.

(4) Dilatation tests have shown that :

(*a*) Maximum isothermal growth of ingot mould irons occurs at 700 deg. Cent. with little growth below 600 deg. Cent. and none above the Ac_1 temperature.

(*b*) The amount of growth occurring in five hours at 700 deg. Cent. can be regarded as a measure of susceptibility to growth.

(*c*) Growth occurring in this standard test can be estimated from the relation :

Growth, per cent = 0·32 — 0·21 Mn per cent + 0·13 Si per cent — 0·73 P per cent.

(*d*) There are indications that mould life decreases as susceptibility to growth increases.

(5) Stress measurements on ingot moulds have shown that :

(*a*) The actual values of the stresses set up during teeming can be determined only if certain properties of the particular mould material, e.g., stress/strain curves at room temperature and at 400 deg. Cent., Poisson's ratio, and the coefficient of linear expansion, are known. On the other hand, it has been shown that for all the mould irons examined there is an almost constant relationship between stress and strain if the former is expressed as a percentage of the ultimate tensile stress of the particular iron.

(*b*) Stresses equivalent to approximately 70 per cent of the ultimate tensile stress of the mould irons have been calculated from strain measurements made at two positions on one design of mould, during and after teeming. This stress approaches closely the "endurance" strength of the mould materials and it is thus not surprising that the moulds tested frequently fail by cracking.

No further mathematical work on the calculation of stresses from the mechanical and thermal properties of moulds has been carried out. To carry out any such calculations additional mechanical test data up to at least 800 deg. Cent. would be required and, even with these data, the calculations would prove extremely difficult because of the difficulty of taking into account plastic deformation and relaxation of stress with time, at elevated temperatures. It is, therefore, not proposed to pursue this method of dealing with the problem at the present time.

INGOT HEAT CONSERVATION: INGOT MOULD TEMPERATURE MEASUREMENTS

By R. T. Fowler, B.Sc., Ph.D., and J. Stringer, B.A.

Synopsis

Further measurements on the surface temperatures of an ingot mould have been made, and the technique of temperature measurement by fixed thermocouples has been extended to include temperatures through the walls. Two trials were made with the mould initially at a temperature of 30 deg. cent., and one trial with the mould at 125 deg. Cent., the latter being representative of normal practice. Temperature gradients and isotherms have been plotted to give a picture of the overall temperature distribution throughout the mould at various times from teeming. From the results obtained, the heat content of the mould was calculated and the amount of heat removed from the steel during solidification was estimated.

TEN-TON INGOT MOULDS: A COMPARISON OF DESIGN AND CONDITIONS OF USE

By A. Jackson, A.Met., F.I.M.

Synopsis

The design and life of two types of 10-ton mould and bottom plate are compared under normal conditions of use and, for the later type, the results of detailed experiments, designed to indicate the effect of certain variables in the conditions of use, are shown. Both types produce the same ingot size, but the mould design was later modified and improved by alterations based on the failings of the earlier design. The effects of short and long tap-to-strip times and normal and long cooling times between heats are evaluated. The various kinds of failure are discussed and conclusions indicate the possibility of very high mould lives being achieved, provided stripping is sufficiently rapid. Experiments are described on the heating and cooling rates of moulds, the effects of annealing on mould life, and the effect of order of manufacture.

Dr. R. T. Fowler (presenting the paper by himself and Mr. J. Stringer): Since this paper was published, weights and measurements of test ingots of killed and rimming steel have shown that the assumed density of 7·856 grammes per cubic centimetre used in calculating the heat content in calories per gramme steel was too high and figures of 7·3 and 6·67 grammes per cubic centimetre respectively were more appropriate.

Discussion

Mr. N. H. Bacon (Steel Peech and Tozer, Ltd.): The paper by Fowler and Stringer has proved a most useful piece of work, because it shows how strongly the heating of the mould is affected by the surroundings—by the pit walls, by full or empty moulds and by slag pots. It is a cause of wonder that we should still be treating moulds in such barbarous fashion. With all the millions of pounds that we are spending on steelworks we should be alive to the fact that it would be well worth while to make a casting pit of sufficient size to treat ingot moulds in a proper manner. Some means of cooling—for example, by means of fans—might pay good dividends in improved mould life. In the paper by Fowler and Stringer, in trial No. 4, for example, sixty minutes after casting, the narrow side of the mould, next to an empty mould, was 60 deg. to 90 deg. Cent. cooler than the opposite narrow side, which was adjacent to a slag pot. The trials also showed that an adjacent full mould led to higher temperatures than did the close proximity of a slag pot. The effect of the pit walls appears to be very similar to that of adjacent hot moulds. Dr. Fowler mentions that the normal temperature at which the moulds were used was 125 deg. Cent., which seems to be very high, and those moulds which were actually used at 125 deg. Cent. showed variations of 90 deg. Cent. from one part of the mould to another. Another interesting fact brought out by the authors, which was new to me, is that in some cases the corners of the moulds may get hotter than some of the faces. That may account for the fact that some companies find it better to make the corners as thick as the walls, while some make them thinner. This irregular heating of the mould is one of the most important factors in reducing mould life. This leads me to think that, in addition to getting our directors to spend more money on the casting pit, we should exert ourselves to find some means of cooling the moulds, for example by fans.

Turning to the paper by Jackson, this work, in addition to demonstrating the importance of removing the mould from the ingot at the earliest possible time compatible with good steel-making practice, has proved that moulds with an initial temperature of about 50 deg. Cent. suffer less damage during service than moulds which have fallen to room temperature. That is important, because at one time we thought that the cooler the mould the better. A temperature of 50 deg. to 70 deg. Cent. is probably the optimum.

Another interesting fact which Mr. Jackson's work illustrates is that a good life is attainable even when extra quick stripping is not possible, as, for example, when the ingots are made with a feeder head. Beyond a certain time it does not matter how long you leave the metal in the mould, provided, as I say, that you give the mould time to cool down, so that with a stripping time of two to two and a half hours, which is often necessary with brick top moulds, it is still possible to get a life of about 100 and a consumption figure of 20 lb to 22 lb per ton of steel, which is a great improvement on the normal 50 lb for brick top moulds.

The paper by Heselwood and Pickering (in the symposium) is of particular interest because it gives some indication that irons having the higher growth rates result in moulds giving shorter lives. Although the paper gives an indication that growth and mould life have a negative correlation, mould life decreasing with increasing growth, the number of tests, as the authors point out, is not sufficient to make them really significant. The authors, however, have produced a formula showing that silicon, manganese and phosphorus are important factors in growth. It seemed reasonable, therefore, using that formula, to go into the matter further by working out the growth for large numbers of moulds and then seeing how the calculated growth compared with the life. I have done that.

M. M. Olette (Institut de Recherches de la Siderurgie): In a recently published report on a study carried out in France at the Institut de Recherches de la Siderurgie, M. Rocquet and I tried to define the part played by the different factors affecting cast iron growth within the range of temperature usually found in ingot moulds. For this purpose, a series of cast iron bars taken from one melt were subjected to a number of cycles of heating up to a chosen temperature and cooling down to 400 deg. Cent., first *in vacuo* and then in an oxidising atmosphere. The cast iron used had the following analysis, with slight changes from one test piece to the other :—

	Per cent
Total carbon	3·24
Graphite	2·70
Combined carbon	0·54
Silicon	1·62
Manganese	0·58
Phosphorus	0·12
Sulphur	0·08

The tests in vacuum showed that, below the transformation point Ac_1 (about 775 deg. Cent. for the cast iron studied), and after about twenty alternate heating and cooling cycles, the linear growth was small and approached a limiting value of about 0·5 per cent. A micrographic examination of the bars, before and after treatment, showed that pearlite and cementite were completely transformed into ferrite and graphite. These results are in good agreement with Heselwood and Pickering's results obtained after a five-hour isothermal treatment at 700 deg. Cent. On the other hand, temperature cycles up to 850 deg. Cent., i.e., above the transformation point, give a larger growth, but, whereas in the previous test the growth per cent was nearly constant

after the first twenty cycles, in this test the growth increased slightly, but steadily, even after sixty cycles. This result may be explained, as the authors suggest, first by successive solution into the γ phase and precipitation from the α phase of small quantities of graphite, and also by phenomena of distortion and dislocation of the micrographic components of cast iron at the transformation points Ac_1 and Ar_1, as mentioned by Benedicks and Löfquist as early as 1927. However, the linear growth found after seventy cycles was far smaller than the growths noted by the authors with similar cast irons. This suggests that oxidation phenomena were not negligible.

Tests in an oxidising atmosphere at 700 deg. Cent. gave growth values smaller than those found at 740 deg. Cent. *in vacuo*. At this stage graphitisation is probably not yet complete and the influence of oxidation is negligible. At 750 deg. Cent. the results are higher than at 740 deg. Cent. *in vacuo*. Here oxidation begins to have an influence. Above the transformation points, at 800 deg. and 850 deg. Cent., the growths are also very much larger than at 850 deg. Cent. in vacuum. This apparently shows the large influence of oxidation phenomena on cast iron growths. Some determinations of the silica content in bars subjected to temperature cycles in oxidising atmospheres indicated a relation between the growth per cent and the percentage of silicon oxidised.

Ingot Heat Conservation

Mr. F. A. Gray (The United Steel Companies, Ltd.): My remarks will be mainly devoted to the paper by Fowler and Stringer. This is aimed at ingot heat conservation. At present the minimum time which is allowed between tapping and stripping is very largely arbitrary, and there is very little doubt that there is a considerable variation in the stripping times between various works using the same types of ingot in practice. If we are going to practise the maximum heat economy, we must know the minimum time in which an ingot can be stripped to permit safe handling and the minimum transfer time to the soakers, though this is another question. There is a point where the heat content of the cooling ingot is the same heat content as is required for rolling, and the object, therefore, is to attain this ideal as nearly as possible. Thus, if we are to be able to plan the procedure between teeming and stripping, and stripping and rolling, we must know the temperature and heat conditions within the ingot at any time. There are so many variables and basic data which are unknown that it is unlikely that a solution can be arrived at mathematically; the required knowledge must therefore be obtained largely from measurements. One method is to determine the heat flow from ingot to mould and from this to deduce the temperature and heat conditions in the ingot itself, and in this paper we see this line of attack. We have also seen how, under very difficult conditions, the temperature distribution within the mould has been successfully measured at a number of points. The authors have been wise, I think, to use thermocouples inserted into the mould, as the measurement of surface temperature by the types of contact couples at present in use is liable to very large errors. The new hemispherical types of surface pyrometer recently developed by B.I.S.R.A. and Land offer prospects of more accuracy, however, and it would be interesting to hear whether the authors plan to use these instruments in future work and to make comparisons of the results with those obtained by inserted thermocouples. If the new instruments are suitable and reliable the experimental technique will be greatly simplified. Assessment of the conditions within an ingot merely by temperature measurements, while giving valuable information, is an indirect method, and the ideal would be to measure the temperature in the ingot itself. Interest in this problem is by no means confined to the heat economist; it is obviously equally important to the metallurgist and steel maker. Mr. Jackson's paper shows how reduced stripping times have most strikingly increased mould lives. It would be interesting to hear from Mr. Jackson what effect these reduced stripping times and, therefore, higher temperature ingots have on the output and fuel consumption of the soaking pits.

Mr. H. Brooke Freeman (John Summers and Sons, Ltd.): I am interested in the paper by Fowler and Stringer primarily from the metallurgical aspect. I want to know the rate of heat extraction from the ingot in the first few seconds following teeming; during this time the skin of the ingot is formed and the quality of that skin will be reflected in the surface condition of the finished product. I am concerned particularly with low carbon ingots of 6½ to 8½ tons, cast in slab moulds, rimming steel of about 0·07 per cent carbon. The rim of a rimming steel ingot consists of five layers. The first consists of spattered nodules ejected by the steel as it is rising in the ingot. These small particles of steel are ejected by the gases and frozen on the mould walls. That is the first layer. Immediately on top of that comes the second layer of quenched material, quenched on to the first layer by the drastic cooling effect of the mould. The third layer is what I call the solid skin, the solid skin formed under the reaction of FeO+C giving CO+Fe, and forming a very dense and solid skin. The fourth layer is that usually indicated by the rim holes, and the fifth that indicated by rim channels. In making full-finished auto-body sheets and, indeed, in almost any product, the skin formation is important, but in making auto-body sheets it is particularly important, because these layers determine the quality of the surface of the sheet, if the sheet is going to be produced without very extensive de-seaming on either the ingots or the slabs. I am particularly interested in what happens with the first two layers to which I have referred, because very often it will be found that the second layer is porous, the porosity being quite different from that caused by the rim holes. The pores are small, but they lead to the formation of surface defects which auto-body steel makers do not wish to see. As they form in something less than a second—the quenching action is very quick—what happens in the first few seconds following teeming, and in the next period, when these holes form, is very interesting. I am very interested, therefore, in what is the temperature of the mould face, and more particularly, in what happens in the first layer of the ingot, because, as I have said, it is during this time that the skin of the ingot is formed, and the quality of the skin will be reflected in the surface condition of the finished product. In the production of full-finished sheets for auto-body work the prime requisite is an ingot with a good skin. It is well known in making low carbon rimming steel that extremes of mould temperature show marked differences in the behaviour of the metal in the moulds. If you teem rimming steel into a hot mould there is a very big difference in the surface condition of the ingot compared with that which is obtained when you teem into a cold mould. In narrower limits of mould temperature the visible differences are not so apparent; they may be masked by other factors. The rate of freezing at the first contact of the metal with the mould is that of an instantaneous solidification followed by a severe quench. The pick-up of heat by the inner face of the mould must be considerable and the temperature which it reaches will depend in the first place on the rate at which the heat is conducted away from the inside face. The rate of teeming, the condition of the metal—rimming action, and so on—will affect the conditions at the mould face and, in turn, these will affect the formation of the ingot skin.

The method reported in this paper would appear to be capable of extension to provide the required information, namely, the temperature of the inner face of the mould. Indeed, the plugs might even project sufficiently into the mould to record the temperatures obtained in, say, the first ¼in of the ingot skin. Such information as could be obtained in this way would aid us considerably in our conceptions of the mechanism of ingot skin formation, and might also throw considerable light on the vexed question of ingot cracking as I have briefly indicated. The work which the authors are doing is by no means limited in application to the particular problem which they have in mind.

Growth in Vacuo

Mr. J. W. Grant (British Cast Iron Research Association): Following the work done by Heselwood and Pickering, we have in hand some experiments very similar to those about which M. M. Olette has spoken, in a vacuum having a pressure of 10^{-3}mm of mercury, which is the same as the figure he mentioned; but the growths which we have obtained in certain conditions with a vacuum of that kind have been as much as 30 per cent. These were on ingot mould irons. When Mr. Heselwood, in the first place, recorded some growths of more than 2 per cent, which can probably be accounted for by the graphitisation of the matrix, we suspected that the vacuum was not a true one. Mr. Heselwood afterwards agreed that it was not a super vacuum and that a certain amount of oxygen was getting in and probably causing that growth. However, we have repeated the work in what we regard as a good vacuum, and by cyclic treatment for 100 cycles between 600 deg. and 900 deg. Cent. we have obtained, as I say, growths of as much as 30 per cent. It is of interest to mention that in some cases we have annealed the sample beforehand in air, and when that sample is then subjected to the same cyclic treatment, 100 cycles, 650 deg. to 900 deg. Cent., the growth is only 2 per cent, evidently due to oxygen penetrating into the metal and at least temporarily, preventing the growth which occurs with the as-cast material.

Mr. J. Woolman (Chairman of the Stresses in Moulds Panel) replying to the discussion on behalf of the authors of the papers in the Symposium on Stresses in Moulds:

There has been very little discussion on these papers, but I was particularly interested in Mr. Bacon's remarks. It is very unfortunate, of course, that we have not made sufficient progress to date to apply any results to ingot mould design, but there is no reason why, by modifying moulds and measuring the resulting stresses in the way which we have shown, this method should not make it possible to determine the effects of changes in mould design. It is a very long-term project and cannot be done quickly, but I think the work shows that surface stresses can be determined, and we have here a tool, which, if applied to moulds of different

design, will make it possible to determine the various factors of mould design.

Dr. R. T. Fowler (replying to the discussion): In B.I.S.R.A. we are attempting to use surface pyrometers more and more. In spite of the advantages of the thermocouple technique it is a very clumsy method, and you cannot do it on more than one mould at a time unless you are willing to have, say, ten of these calorimeters in the pit, which is verging on the preposterous. Our intention was, therefore, to use this test mould and move it about in the pit into various pit positions and to measure the heat lost from the ingot at various times from teeming to stripping. In this way we shall be able to apply some sort of statistical correlation as to the influences of pit position and the influence of the temperature rise on the mould surface, and also the effect of initial steel temperature and the effect of initial mould temperature. If we can find that there is a satisfactory correlation between the surface temperature rise on the outside of the mould and the heat lost from the steel, we can by the next stage just use one thermocouple, placed at a convenient spot on the mould surface, and employ that as a reference point. The next step would be to dispense with the surface thermocouple and go on to a contact pyrometer, so that, visualised as routine work, a man would just come along and place the surface pyrometer on a selected point on the mould surface, measure the temperature rise, and then, by referring back to certain graphs, be able to estimate the heat loss from the ingot, and, knowing the heat loss from the ingot, it is then possible to estimate how much has to be put back into it in order to bring it up to rolling temperature. That is the objective which B.I.S.R.A. wishes to attain. We do not recommend everybody to put one of these test moulds into a casting pit, though the more data obtained on particular moulds and ingots the better, but we want some sort of relationship with one reference point, and that is what we are out to get.

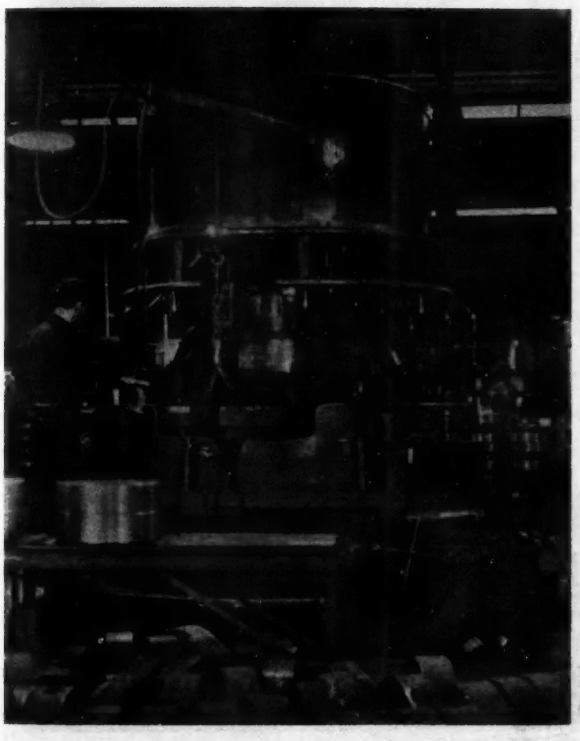
We reach the interesting conclusion that, from the point of view of ingot heat conservation, it is necessary to attempt to strip the ingot before the centre has gone completely solid, because, if you leave it until the centre has gone solid, the removal of 0·5 therm per ton, which may only mean about ten minutes in the mould, will quickly bring the surface down below 1300 deg. Cent. If the centre is below 1300 deg. Cent. and you have to bring it back to 1300 deg. Cent. you have to conduct a fair amount of heat through the entire mass of the ingot for the purpose. It is better, therefore, to strip the ingot just before it goes solid, so that you have a reserve of heat energy in the centre of the ingot, so that when placed in the soaking pit the centre goes down to rolling temperature and the outside goes up to rolling temperature, rather than having to bring both outside and centre up to rolling temperature, with all the attendant heat requirements to conduct the heat right through the mass of the metal.

Mr. A. Jackson also made a short reply. The afternoon session then ended.

(To be continued)

Light Engine Production at a Staines Factory

WE recently were able to pay a visit, at the invitation of the Brush-ABOE Group, to the factory at Staines where the small Petter oil engines are produced. The small engines division of the Group took over the Causeway Works some four years ago, which was then modernised, reconstructed and re-equipped for the mass production of small engines ranging from 1½ to 10 b.h.p., and was described in our issue of October 22, 1948. An initial output of about 500 engines per week was quickly achieved, and this rate of production has steadily increased over the intervening period and has now reached a level of 1500 engines a week, representing an annual value of £4,500,000, 80 per cent of which is exported.

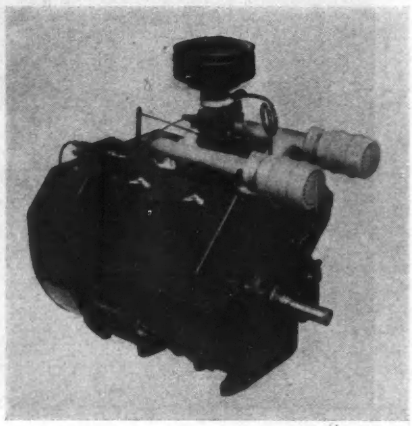


BULLARD TURNING AND BORING MACHINE

The engines at present coming off the production line include single-cylinder, air and water-cooled petrol and paraffin engines, developing 1½ to 3 b.h.p. at 750 to 1500 r.p.m. There is one single cylinder series in which the petrol engines give 4 to 5 b.h.p. at 1400 to 1650 r.p.m., and the paraffin models 3½ to 4 b.h.p. over the same range of speed, while a twin-cylinder design is rated at 6 to 10 b.h.p. over the speed range 1150 to 1650 r.p.m. when using petrol, and 6 to 9 b.h.p. when using paraffin. Two other engines noted were the hopper-cooled, single-cylinder petrol and paraffin models developing 1½ to 2 b.h.p. at 750 to 1000 r.p.m. In addition to the above are the diesel engine series, including air-cooled engines which develop 3 to 4·5 b.h.p. at 1000 to 1500 r.p.m. as a single-cylinder model, and 6 to 9 b.h.p. as a twin unit, and a water-cooled design which gives 3 to 5 b.h.p. at 1000 to 1500 r.p.m. as a single-cylinder unit, and 6 to 10 b.h.p. with two cylinders. The water-cooled models are also produced for speeds up to 1800 r.p.m., the single and twin-cylinder engines developing 6 and 12 b.h.p. respectively.

The vertical, four-stroke petrol and paraffin engines have an 85mm bore by 82·5mm stroke, and the cold-starting, four-stroke, compression-ignition engines have a bore of 80mm by 110mm stroke.

Consisting of modern buildings, the factory now covers an area of 220,000 square feet, and the assembly lines are arranged so that six different engine models can be produced simultaneously. To increase the total production still further, all the assembly tracks and conveyors are being converted to power drive, and plans have been drawn up for the resiting of equipment in the machine shop so as to produce uninterrupted lines of flow from the raw material stores to the point of despatch. Within the machine shop, with its floor area of 30,000 square feet, are some 275 modern motor-driven machines. As at present arranged, the larger components move along eight main lines while the operations on the smaller parts are completed by groups of machines, an arrangement which reduces handling and tracking movement to a minimum. Multi-drilling and multi-boring methods are widely used, and four-way drilling machines having fifty-four spindles simultaneously drill the sides, top and back of the crankcases. The engine flywheels have all operations completed on one machine, which is the Bullard turning and boring machine seen in our illustration, and it has eight stations, one being the loading point. Placed on a rotating table, the wheels are bored and the outer surfaces and the centre boss are faced, the average time for finishing each flywheel being about four and a half minutes. In the production of crankshafts and other components it was noticed that multi-tool machining was being used, and it is understood that single-point and profile machines are to be introduced eventually.



AIR-COOLED PETROL ENGINE

From the assembly conveyor line, and associated sub-assembly bays, single-cylinder engines are produced at a rate of one every two minutes, while the average time for the twin-cylinder model is three minutes. The completed engines pass to the new test shop, which has fifty test beds and is illustrated on the next page. The supply lines of petrol, paraffin, diesel oil and water to the test beds are carried in underground ducts as is also the exhaust piping from the engines on test. Petrol engines are tested for one hour and diesel engines for one and one-quarter hours, and the latter are

started up on slave fuel injectors, so that any starting troubles can be traced directly to the engine.

The several laboratories are fitted with chemical, metallurgical and electronic equipment, and of particular interest is the magnetic sorting bridge which rapidly sorts steel bars and detects minute variations in chemical composition and heat-treatment.

During the course of the inspection of the factory a number of prototype models of a new engine were noticed on the assembly line. This engine, Mark PAV4, is an air-cooled petrol engine with the four cylinders set at an included angle of 90 deg. and is illustrated on page 771. Designed to develop 19 b.h.p. at 2000 r.p.m., the cylinders have a bore of 85mm by 82·5mm stroke, and the b.m.e.p. is 66 with a piston speed of 1083ft per minute. With the express purpose of avoiding any break in the production flow of the present range of engines, the new model incorporates in its design as many parts as possible which are interchangeable with those of current engines. Cylinders, cylinder heads, pistons, gudgeons, valves and springs conform to the specification of the "P.A." engine, while the connecting-rod is interchangeable with the "A" series design.

The crankcase is completely new and carries the two-throw crankshaft in three main bearings, and lubrication of the engine is effected by a gear-pattern pump which has a full flow oil filter. In the design the camshaft and other ancillary drives are placed behind the flywheel fan so that the opposite end of the engine can be adapted to take any form of power drive.

With the introduction of this engine the company have a series of petrol engines ranging from 3 to 19 b.h.p., and, as the new engine is interchangeable with an American model, the new production should take the place of the American engine in the non-dollar markets.

ENGINE TEST SHOP

NEW CATALYST PLANT.—Last week Sir Geoffrey Heyworth, the chairman of Lever Brothers and Unilever, Ltd., opened a new catalyst plant at the Bank Quay works of Joseph Crosfield and Sons, Ltd., Warrington. Following upon agreements between Joseph Crosfield and Sons, Ltd., and the Davison Chemical Corporation of Baltimore, U.S.A., and a number of oil companies, the plant for manufacturing a catalyst required for certain oil refinery operations has been built and will commence operating by the end of the year. The Davison Chemical Corporation, whose process will be used, has given technical advice regarding the plant design and operation. The raw material is sodium silicate and the plant equipment includes two Svenson Evaporator Company stainless steel dryers, together with automatic temperature, pressure and flow controllers.

Jubilee of First Transatlantic Wireless Transmission

LAST Wednesday, December 12th, marked the fiftieth anniversary of the first transmission of wireless signals across the Atlantic. This achievement, which justified Marconi's faith in the possibilities of telegraphy without wires, was accomplished only four years after he had first demonstrated to the G.P.O. that intelligence could be passed between two places a few yards apart, using the ether as a medium and following the principles established by Hertz and Maxwell.

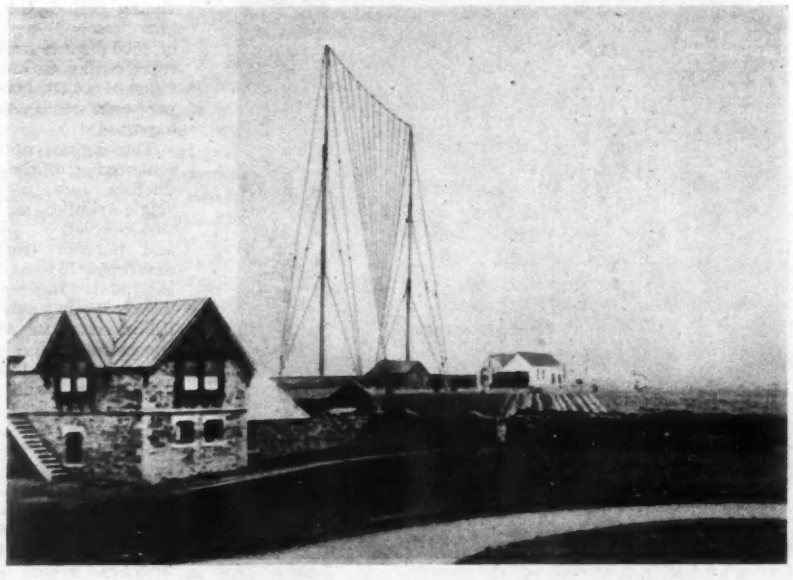
In acknowledging the part played by Marconi in the practical development of wireless telegraphy we may recall that the first wireless patent was taken out in 1896 and the following year saw the formation of the Marconi's Wireless Telegraph and Signal Company, Ltd. Wireless equipment was ordered first by the Royal Navy and later by other authorities. In 1898, wireless telegraphy was used, in Naval manœuvres, across distances up to 74 miles, and, on land, the new method of communication was used in the South African War. Nevertheless, until 1901 there was little growth in the range of transmission by wireless signals, and there appeared to be little evidence to support Marconi's confidence in wireless telegraphy as a means of spanning large distances.

Accordingly, when Marconi proposed to put his ideas to a practical test by sending signals from England to Newfoundland, his project was received with widespread scepticism. Fortunately, however, Marconi's vision was backed by a generous measure of determination and his enthusiasm was shared by his small team of engineers and associates, which included Kemp and Paget.

A suitable site for the transmitter was chosen on high cliffs at Poldhu, near Mullion, in Cornwall. There work on building the transmission station was started in October, 1900. Much of the responsibility for the transmitter design fell on Professor J. A. Fleming, F.R.S. (better known, later, as Sir Ambrose Fleming, inventor of the thermionic valve). The station was to be a hundred times more powerful than any of its predecessors and the amount of existing data that could be applied to the new venture was extremely limited. Nevertheless, the transmitter was ready for preliminary experiments in January, 1901.

A major setback was experienced on September 17th, when a gale wrecked the aerial, which consisted of a ring of twenty wooden masts, 200ft high, and arranged in a circle 200ft in diameter supporting 400 aerial wires in the form of an inverted cone. This structure was replaced by a smaller and simpler system (illustrated herewith) consisting of a fan-shaped array of fifty-four wires suspended from a triatic at 1m intervals at a height of 150ft.

As a result of the preliminary trials transmitting apparatus was eventually evolved for the attempt to send signals across the Atlantic. It is recorded that power for the transmitter was obtained from a 32 h.p. Hornsby Ackroyd oil engine driving a Mather and Platt 50 c/s alternator, with an output of 25kW at 2000V. Two 10 : 1 ratio transformers, connected in parallel, raised the voltage to 20kV at which the output was connected through h.f. chokes to a closed oscillatory circuit in which a condenser was discharged across a spark gap through the primary winding of a h.f. transformer. The secondary winding was connected



POLDHU WIRELESS STATION, DECEMBER 1901

to a second spark gap and condenser and to the primary winding of a second h.f. transformer. The secondary winding of this transformer was in series with the aerial. Keying of the transmitter was done by short circuiting chokes which were connected in the output from the alternator.

Our second illustration shows some of the early apparatus at the Poldhu wireless station. On the extreme left are the transformers. Behind them are the banks of condensers, carried in metal containers in the wooden racks. On the extreme right is the spark gap consisting of two steel spheres mounted on insulating rods.

Each of the condensers was built up of twenty glass plates, 16in square, coated on each side with 1 square foot of tinfoil, the assembly being housed in a stoneware box filled with linseed oil.

In the meantime, a corresponding receiving station had been under construction at South Wellfleet, Cape Cod, Massachusetts, but the circle of aerial masts suffered the same fate as the original 200ft array at Poldhu, and it was decided to move to Newfoundland for the first attempt to receive the signals. Marconi, with his assistants Paget and Kemp, left England on November 27, 1901, and arrived at St. John's, Newfoundland, on December 5th. Using the facilities offered by Sir Cavendish Boyle, the Governor of the island, and Sir Robert Bond, the Prime Minister, Marconi

EARLY APPARATUS AT POLDHU WIRELESS STATION

was able to establish his receiving station in a building at Signal Hill.

Initially, the long receiving aerial at Signal Hill was supported by a balloon, but, on its first ascent, when the weather was rough, it broke away and was lost. Another attempt was made on the following day, Thursday, December 12th, when a 500ft long aerial was raised on a kite, but within an hour it had been carried away by strong winds. A second kite was then tried and it flew successfully, at a height of 400ft, supporting an aerial. The rise and fall of the kite caused variations in the capacity of the aerial and precluded the use of any of the syntonic receiving apparatus then available. Use was therefore made of a simple receiving circuit consisting of a self-restoring coherer in series with the aerial and a telephone earpiece.

Transmission had begun from Poldhu on Wednesday, December 11th, in accordance with an arrangement whereby the letter "S" was to be sent in Morse, continuously from 3 p.m. to 6 p.m. Greenwich time each day. When the receiving aerial was successfully rigged at Signal Hill on December 12th, the signals transmitted from Poldhu were received as recorded by the following modest entry in Marconi's diary: "Sigs. at 12.30, 1.10 and 2.20."

The Measurement and Interpretation of Machinery Noise with Special Reference to Oil Engines*

By C. H. BRADBURY, M.I.Mech.E.

Classification of Noise

Machinery noises may be broadly grouped into two classes: those noises with frequencies which bear a definite relation to the speed of the machine under investigation, or the components of that machine; and noises which do not bear this relation. These classes are known under various titles. In the United States, and to some extent in Britain, they are known as "pitched" and "unpitched" noises respectively. Owing to the other, more common use of the word "pitch" in connection with sound, the use of this term in the American sense is not universally favoured in Britain, and the terms "harmonic" and "response," respectively, have been suggested. As the latter terms are not yet fully established and the former are well known, the terms "pitched" and "unpitched" will be used in this paper.

Typical examples of sources of pitched noise are firing impulses in oil engines, gear tooth frequencies in gearboxes, and electric motor hum in machine tools. Unpitched noises are usually shock-excited, and noise emission is caused either by vibration at the natural frequency of the particular machine part which receives the shock excitation, or by some form of reverberation. Examples of this type of noise are valve spring surge in internal combustion engines and drumming inside machine covers.

Machinery noise almost invariably contains both pitched and unpitched components. The former often predominate where mass and stiffness are great, the latter in machines of very light construction. It is this second class of machine which provides the noise reduction engineer with his biggest problems.

Some Methods of Measurement

An ideal prerequisite to accurate measurement is, of course, an acoustically "dead" room, such as that used at recognised acoustical laboratories. A second ideal requirement is a staff specially trained in the operation, maintenance and calibration of the measuring equipment.

Whilst these ideals may ultimately be attained, investigations are limited at present to engineering shops or installed machinery locations, where conditions may be far from perfect. Background noise and sources of reflection are always present, and, as mentioned earlier, instruments with known limitations must be used. Nevertheless, some very useful methods of measurement have been devised and are now in regular use.

(1) *General Sound Level.*—In this method the microphone is placed at equal intervals round the machine and the resulting readings are either averaged as decibels, if they all lie within

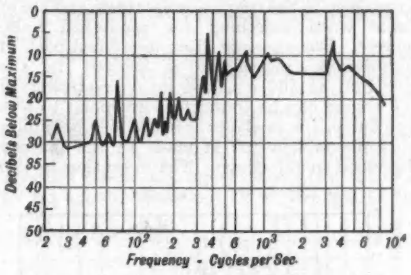


FIG. 1—*Typical Narrow-Band Analysis*

a range of 10 decibels, or first converted to intensity, averaged and then converted back to decibels, if the range is more than 10 decibels. Care must be taken that the background noise, with the machinery stationary, is at least 20 decibels and, if possible, 30 decibels below the sound level with the machine running; this same rule applies in general to all measurements. Measurements in a restricted room or shop should be avoided so that reverberation is reduced to a minimum.

Up to the present this method of measurement has proved to be almost valueless both for recording or investigating. Many different types of noise can have equal sound levels and the statement that the average sound level is x decibels is now regarded as having little meaning.

(2) *Equal Sound Level Contours.*—To obtain these contours a microphone traverse is made of the plane under investigation up to a distance of, say, 18in from the machine, and points of equal sound level, when joined by continuous lines, give the contours.

(3) *Frequency Spectrum or Narrow Band Analysis.*—The spectrum, an example of which

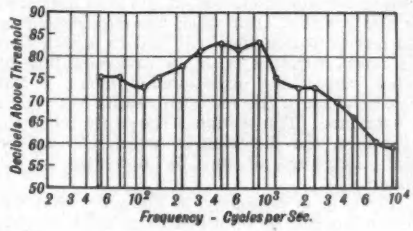


FIG. 2—*Octave Analysis*

is shown in Fig. 1, is obtained by means of the narrow band analyser. This method has the advantage that, with a wide range of microphone positions, predominant frequencies are clearly shown and, with a full knowledge of the machine characteristics, sources of noise can often be traced.*

The example of Fig. 1 is taken from a turbo-charged oil engine. The peak of 75 c/s is at the engine firing frequency, that at 370 c/s is at the turbo-charger speed, and that at 3700 c/s is at the frequency of the turbo-charger impeller blades.

A further use of this method of analysis is the segregation of pitched and unpitched noise.

* Institution of Mechanical Engineers, December 7th. Abstract.

* There is considerable doubt regarding the accuracy of the flanks of the narrow band analysis. How much of the flank is due to sound and how much to instrument imperfection is not known. Consequently there may be masking of low-level components in the flank of a nearby high-level component.

If spectra are taken at two different machine speeds and results are compared, pitched peaks will move in proportion to the speed, whilst unpitched peaks will remain constant in position whatever the speed.

(4) *Octave Analysis.*—This is again a frequency spectrum, but it differs from that of Fig. 1, as it is obtained with an octave filter. The instrument is a variable band-pass filter which selects octave ranges in two groups: the first group is 37·5–75, 75–150, . . . up to 4800–9600 c/s; and the second 50–100, 100–200 . . . up to 6400–12,000 c/s. A plot of the readings gives the spectrum which indicates the general distribution of the noise being measured. A typical octave analysis is shown in Fig. 2, the ordinates being the sound levels recorded at the respective mid-band frequencies.

(5) *Constant Frequency Contours.*—These are a corollary to the frequency spectrum and are of value when searching for unpitched noise sources. For example, if an unpitched peak of considerable magnitude is present in the spectrum at 400 c/s, and no characteristic of the engine can be found to correspond to this frequency, the analyser is set at 400 c/s and a microphone traverse is made in the manner described in (2) above. The exception in this

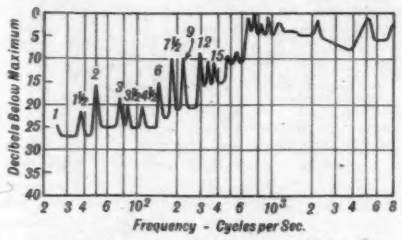


FIG. 3—*Spectrum of Three-Cylinder Oil Engine*

case is that only one contour is required and that relative sound levels will provide the information required.

(6) *Sound on Film.*—Here the output of the sound level meter is applied to a cathode ray oscillograph, and a record is taken on a continuously moving film. The film strip is interpreted either by the known sequence of events that have been recorded or by a timing mark applied to the second beam (if the oscillograph is so provided). The virtue of this method has not yet been fully assessed, but it appears to be of value when measuring impulsive noises.

Interpretation of Results

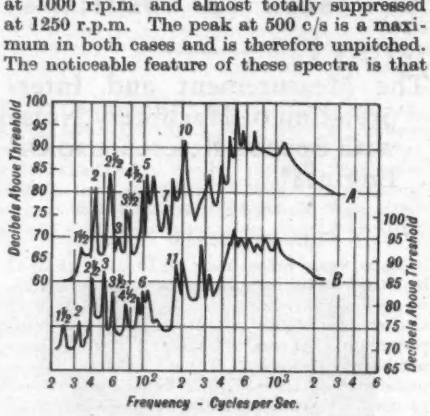
Here the difficulties arise. None of the methods of measurement already mentioned is beyond the powers of a specialist engineer; a reasonable interpretation on the lines indicated is also possible. But when the requirement is an interpretation that will lead to a reduction of noise, together with an understanding of what constitutes objectionable noise, a full appreciation of the recorded results has yet to be attained. This section of the paper indicates, therefore, the direction in which the author feels that some advance in knowledge can be made.

First, it is necessary to consider what information can be obtained from noise spectra and what typical characteristics they exhibit, and for this purpose a number of examples will be used.

Spectrum of Three-Cylinder Oil Engine.—Fig. 3 shows a spectrum taken from a three-cylinder, four-cycle oil engine running at 1500 r.p.m. Identifiable peaks are designated by order numbers, the number being the frequency of the component per revolution of the engine. "Order 1½" is therefore the firing frequency. Interesting features of this spectrum are: (*a*) the relative unimportance of the basic firing frequency; (*b*) the magnitude of orders 7½, 9 and 12; (*c*) the absence of certain half-orders; (*d*) that the highest peaks cannot be identified with certainty.

The general sound level of the engine was 99 decibels and the noise would be classed as "objectionable."

Spectra of Six-Cylinder Oil Engine.—Fig. 4 shows two spectra taken from a six-cylinder, four-cycle oil engine running at two different speeds, 1000 r.p.m. and 1250 r.p.m. "Order 3" is the firing frequency, and it is clearly defined at 1000 r.p.m. and almost totally suppressed at 1250 r.p.m. The peak at 500 c/s is a maximum in both cases and is therefore unpitched. The noticeable feature of these spectra is that



A 1250 r.p.m. (general sound level, 102 decibels).
B 1000 r.p.m. (general sound level, 101 decibels).

FIG. 4—*Variation in Narrow-Band Spectra with Speed*

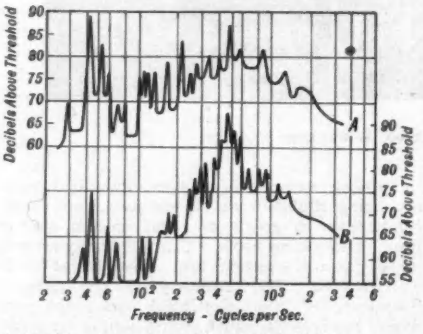
the peaks appear to be zoned irrespective of order number, i.e., peaks are high from 40 to 60 c/s, from 90 to 130 c/s and from 180 to 250 c/s, in addition to that at 500 c/s. Some form of box resonance with the engine structure is therefore indicated, but the root cause of the resonance is not clear.

Fig. 5 shows two further spectra from the same engine at 1000 r.p.m.; the first is taken with the engine motored, and the second with the engine motored without pistons but with the normal fuel injection. These spectra immediately give a clue to the major disturbances. From the upper curve it is seen that the power stroke, whether firing takes place or not, is mainly responsible for the low-frequency zone of noise from 40 to 60 c/s. The lower curve shows that the fuel injection equipment excites the unpitched noise at 500 c/s and, in addition, has some exciting effect at the lower frequency.

The general sound levels are indicated with the various spectra. In the first, second and fourth spectra the noise was "objectionable." In the third the engine was relatively quiet.

Octave Spectra.—Before discussing these results further it is desirable to take a little wider view in order to obtain a more complete picture of various types of machinery noise, and the octave analysis can throw some light on this subject.

Four examples have been chosen and they are shown in Fig. 6. The first is a noisy oil



A Motoring (general sound level, 95 decibels).
B Motoring without pistons, but with fuel injection (general sound level 94 decibels).

FIG. 5—*Narrow-Band Spectra Under Motoring Conditions at 1000 r.p.m.*

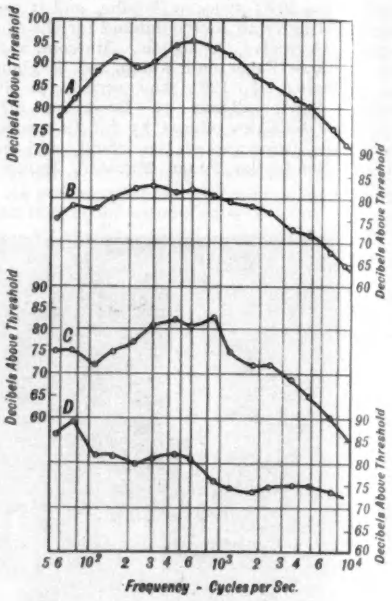
engine, the second a large rotary converter, the third a relatively quiet oil engine, and the last a heavy-duty motor-driven reciprocating air compressor which is classed as "quiet." These four examples were classified by the ability to carry on a conversation in close proximity to the machinery. In the first conversation was impossible; in the last it was normal.

Examination of these four spectra shows that objectionable noise is associated with frequencies over 500 c/s and that an octave analysis with a "hump" at the low-frequency end can indicate machinery which makes relatively little noise—in spite of the fact that the highest level may be 90–100 decibels, where the ear responds equally well to a wide range of frequencies.

To elucidate this matter further six more diagrams are presented in Fig. 7. In these diagrams the range of the sound peaks, measured from the narow-band spectrum, has been plotted on the Fletcher-Munson contours. These curves represent the "break through" of discrete frequencies from the general sound level recorded over the frequency ranges. These examples show clearly that for subjective quietness, not only must the hump be at the low-frequency end, but that "peakiness", of the spectrum must be kept to a minimum at the higher frequencies, particularly if the sound level is over 80 decibels at these frequencies. Peakiness at the low-frequency end is relatively unimportant.

Further Considerations

Thus far it has been possible to examine various methods of measurement and recording and to reach certain conclusions. It is now



A Noisy oil engine
B Rotary converter
C Relatively quiet oil engine
D Air compressor

FIG. 6—*A Selection of Octave Spectra*

necessary to go further and consider: first, the implications of the subjective terms used ("objectionable," &c.), and secondly, how noise can be made less annoying.

Objectionable Noise.—It has already been mentioned that the subjective classification of the four examples discussed under the octave spectra (Fig. 6) was made on the basis of ability to carry on a conversation in the vicinity of the machine. This classification, though useful, is not universally satisfactory. Normal speech occupies a relatively limited frequency range, and if the sound level in this range is greater than that of a loud voice, conversation will be difficult.

It is very necessary, however, to compromise on the subject of annoyance and to narrow the investigation to the problem of reducing machinery noise to a level acceptable to the location in which the machine is working. This means, in general, an ability to carry on conversation without difficulty, and avoidance of nervous strain when working manually or mentally in the immediate neighbourhood.

Reduction of Annoyance.—Referring back now to Fig. 7, examples *c*, *d* and *e* could all be described as machines which would produce nervous strain whereas *a*, *b* and *f* would not, and it will be seen that *c*, *d* and *e* all have sound levels of 80 decibels and over, in the range 1000–5000 c/s. There is good reason to believe that this characteristic is the most potent factor in this system of classification.

To make the noise less annoying, therefore, consideration must be given mainly to the re-

duction of sound levels in the range 200–10,000 c/s. In all but very high-speed engines, this frequency range is well beyond the basic disturbing frequencies of pistons, firing strokes, injection gear, &c. The sounds are thus unpitched or response frequencies, and their excitation is due fundamentally to design.

Although this statment could be interpreted as an indictment of the designer, it is not strictly so. In the present state of the art, all possible frequencies cannot be calculated beforehand. Considerations of cost, weight and size often have to take precedence on the drawing board, and the shapes of cavities in which resonance can take place are quite unalterable when ease of casting and machining must be given preference.

It is possible, nevertheless, to formulate certain rules in the design of oil engines which will lead to quieter operation, and in laying down these rules it must be borne in mind that, since high-frequency sound is caused by undamped vibration which is shock-excited, the primary objective must be to reduce shock loading.

Sources of Engine Noise

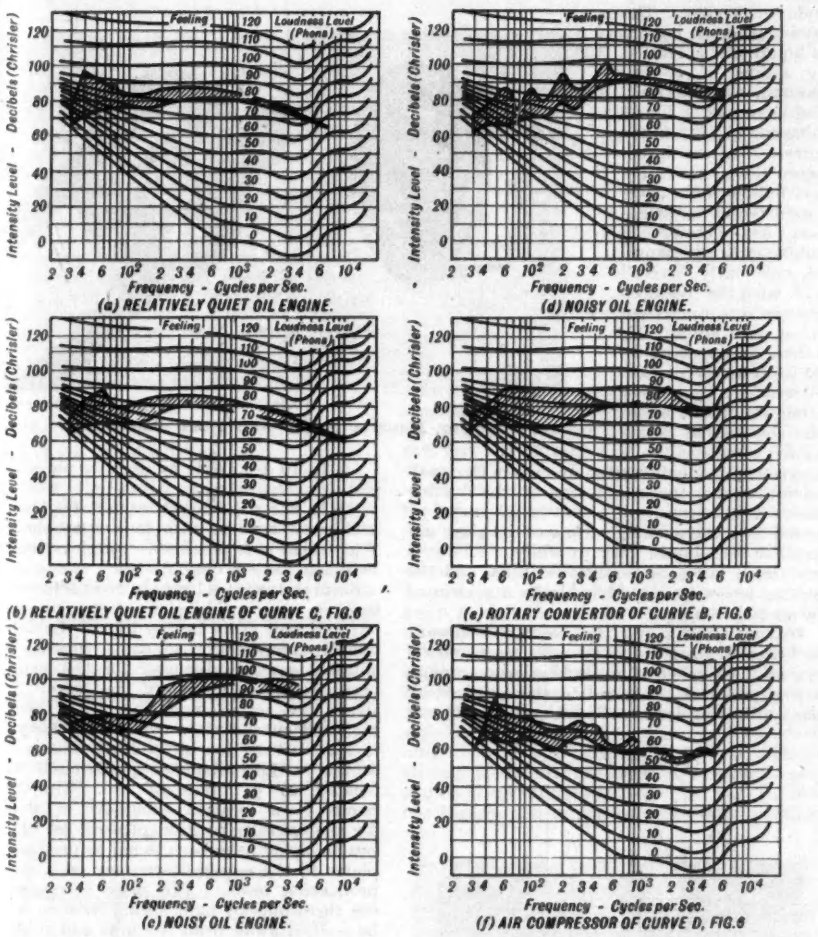
Under this heading it is proposed to consider the functional parts of the engine which produce, (*a*) noise at their operating frequency, or (*b*) shock loading conditions which result in unpitched or response noise. Broadly grouped they are as follows :—(1) Piston and connecting-rod mechanism, (2) the firing impulse, (3) valve gear, (4) the fuel injection equipment, (5) torsional vibration in the crankshaft. The subject of superchargers is regarded as distinct from the engine and is not considered here.

(1) *Piston and Connecting-Rod Mechanism.*—Here the main source of noise is what is popularly known as "piston slap" combined with clearance in the bearings. Piston slap cannot be completely abolished, for a running clearance is necessary, but it can be very much reduced by the use of low-expansion piston material and a close control of the piston clearance "shape" from skirt to top ring. As the temperature of the piston varies but little from the skirt to just above the gudgeon, there is much to be said for making this section completely parallel and letting it act as a crosshead for the whole piston.

(2) *The Firing Impulse* is one of the principal contributors to engine noise, but its significance is not yet fully understood. Some years ago it was popularly believed that, if the rate of pressure rise from near the end of the compression stroke to the point of maximum pressure did not exceed 40 lb per square inch per crank degree, combustion noise would be negligible. Subsequent observations have shown that this is not true.

With the high-compression, oil-ignition gas engine for example, the reduction in combustion noise can be most marked when changing over from 100 per cent oil to 90 per cent gas plus 10 per cent oil, yet the indicator diagrams may show a greater rate of pressure rise on gas. Just how much of this noise reduction is due to the lighter loading of the fuel injection equipment is not clear, but there is good reason to believe that combustion is indeed quieter.

In the normal oil engine the ratio of maximum to compression pressure would appear to be a controlling factor. If this ratio is of the order of 2/1, noisy combustion is extremely likely whether the amount of pressure rise is due to early injection timing or to a long delay period coupled with a phase of uncontrolled pressure rise. In the former case the rate of pressure rise is usually less than, and in the latter case more than, 40 lb per square inch per crank degree.


Feeling
Loudness Level (Phons)
Intensity Level - Decibels (Christer)
Frequency - Cycles per Sec.
(a) RELATIVELY QUIET OIL ENGINE.
(b) RELATIVELY QUIET OIL ENGINE OF CURVE C, FIG.6
(c) NOISY OIL ENGINE.
(d) NOISY OIL ENGINE.
(e) ROTARY CONVERTOR OF CURVE B, FIG.6
(f) AIR COMPRESSOR OF CURVE D, FIG.6

a Relatively quiet oil engine
b Relatively quiet oil engine of curve, *C* Fig. 6
c Noisy oil engine
d Noisy oil engine
e Rotary converter of curve *B*, Fig. 6
f Air compressor of curve *D*, Fig. 6

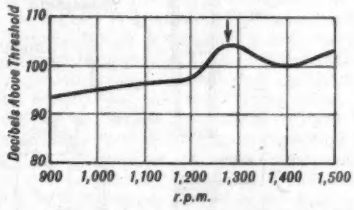
Fig. 7—*Intensity Zones from Narrow-Band Spectra Superimposed on Fletcher-Munson Contours*

With regard to the use of pilot injection to reduce combustion noise, whilst the principle is undoubtedly right in theory, there is as yet little evidence to show how much of the noise reduction claimed for various systems is due to improved combustion, and how much is due to the reduced shock loading of the injection system. Until these two functions can be clearly separated and measured, judgment must be withheld.

(3) *Valve Gear* can be designed on the drawing board to be almost noiseless, and if operation were to design principles it would, indeed, be quiet. Unfortunately, the very exact velocities and accelerations that are calculated are often completely upset by the too popular practice of either operating fuel pumps from the same camshaft or allowing the fuel pump reactions to be transmitted to the valve gear camshaft. For quiet operation the two must be segregated as much as possible.

(4) *Fuel Injection Equipment.*—There is good reason to believe that the fuel injection equipment is the major source of oil engine noise.

Unfortunately, in the present state of knowledge high combustion efficiency is obtainable only by the production of an extremely sharp pressure rise in the injection system, followed by an equally sharp cut-off at the end of the injection period (reference is here restricted to the jerk pump system). These phenomena involve shock loading and shock release, not only hydraulically, but also in the camshaft and the fuel pump support. The former can upset valve gear, as mentioned earlier; the latter reacts on the engine frame.



The arrow shows position of sixth-order critical speed

Fig. 8—*Sound Level Readings Showing Effect of Critical Speed*

The actual location of the fuel pump on the engine frame determines whether or not the high-frequency noise will be of considerable magnitude. Too much thought cannot be given to this feature. The pump must be adequately supported and the point of support must be ribbed to eliminate any possibility of a diaphragm effect. Further, the ribs must be so located that they cannot cause cavity resonance.

(5) *Torsional Vibration in the Crankshaft.*—The noise associated with critical speeds in oil engines is well known. In torsional vibration the motion of the crankshaft is such that the journals oscillate to and fro across the bearing clearance and hammer the bearings at the critical frequency. This hammering produces noise in the form of a low rumble. Additionally, if the camshaft is driven from a point in the shaft remote from the node, the vibration is transmitted to the valve gear where a rattle is produced.

No engine is run intentionally at a violent critical speed, but many engines operate at a speed in fairly close proximity, and it is not generally realised how wide the noise range can be. Fig. 8 is a record of the general sound level of a six-cylinder engine over a speed range which includes the sixth-order major critical speed. The effect of torsional vibration, and its range, is clearly shown.

One further point deserves mention, but only a little subjective evidence is available. This is the omnibus point of joints and jointing materials.

The one joint that appears to be vitally important is that between cylinder head, liner and crankcase. Metal-to-metal joints of the conventional spigot type, employing a ring of hard copper or similar metal, are usually judged to cause more noise than relatively soft composition gaskets, which, though compressed solid, provide a semblance of an acoustic "break" across the combustion chamber.

A Periscopic Sextant

THE advent of pressurised aircraft has made it necessary completely to redesign the conventional air sextant to conform with airframe requirements. It being no longer desirable or practicable under these new flying conditions to provide an astrodome with the requisite optical properties, sighting about the axis of vision now involves the use of a periscopic sextant having its index prism protruding through the airframe and sealed both within itself and on its mounting against the pressure differences which are experienced in flight. Such an instrument has been developed by Kelvin and Hughes, Ltd., Barkingside, and is now used by both military and civil aircraft in this country and elsewhere. This sextant incorporates also an interesting mechanical integrating mechanism with which it is able to determine directly the mean altitude of the celestial body during the period of the observation.

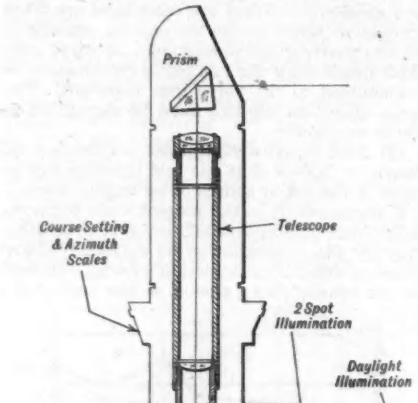


FIG. 1—OPTICAL ARRANGEMENT OF SEXTANT

There being no astrodome the sextant has to provide means of presetting computed azimuth and altitude angles, yet having a field of view sufficient to accommodate small inaccuracies in these settings. The design compensates also for the large temperature gradients that can exist within the instrument when extended.

The Optical System

The optical system is required to bring and maintain an image of the celestial object into coincidence with some form of artificial horizon. Since the magnification and field of view of such a system are conflicting requirements, large magnification giving a small field of view, some compromise is necessary between the ease of setting and the high light grasp of a high power, and the smaller field of view, making it more difficult to find and identify stars. Consequently a 4× system was chosen with a 7 deg. real field of view.

Further, as the entrance and exit pupils determine, with the light loss, the amount of light passing into the eye, they become important when observing stars through light haze or when using faint stars: a 20mm entrance pupil 5mm exit pupil was adopted. Light loss by reflection is reduced by "blooming" all components.

The optical system is shown in Fig. 1. An index prism is employed, since it gives more light at higher altitudes than the same sized mirror. The primary image given by the objective is reversed by the two lens erector system and, after reflection at an aluminised mirror, is viewed by the eyepiece. Field lenses are used where necessary to maintain the required 7 deg. field of view.

The Artificial Horizon

Of the many kinds of artificial horizon available, the bubble combines the maximum of accuracy and sensitivity. The bubble is an air bubble in liquid and is formed by means of a diaphragm. Previous bubbles have used a liquid mixture to obtain the correct relationship between viscosity, density and bubble radius, but a more recent investigation has obtained a bubble critically damped, sufficiently "lively" and with the required temperature range, using a pure liquid. The bubble is expected to set itself in the vertical to within a quarter of a minute of arc, which on the bubble radius chosen represents a movement of only 0·0001in. In view of the small tolerance and the small size of the bubble itself, it is necessary to remove all traces of grease from the working surface of the glass and to filter the liquid very carefully. Filling is performed in an air conditioned room and the bubble lenses and bubble blocks are cleaned by special techniques.

Having made a good bubble it is necessary to bring an image of it into the main optical system. An image of the bubble, seen through a roof prism, is presented to the eyepiece by the collimating lenses. The aluminised mirror

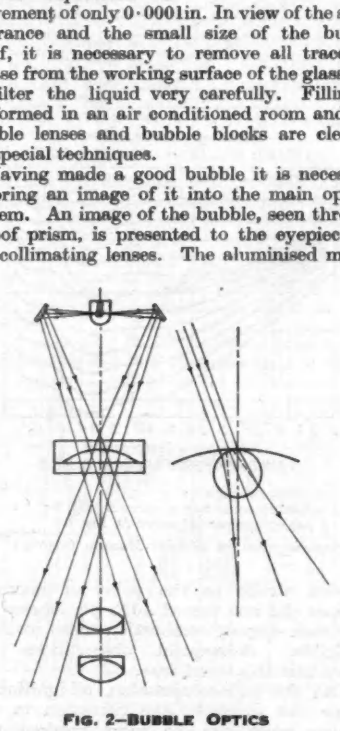


FIG. 2—BUBBLE OPTICS

is made to have 6 per cent transmission and the bubble can be seen through this mirror, superimposed on the main field. The collimating lenses are made adjustable in separation so that the magnification of the system is variable and can be matched to that of the main system. This arrangement ensures that coincidence is maintained on tilting the sextant.

For use with the sun, the bubble is illuminated by a condenser system, thus forming a dark bubble against a bright background, the so-called "day lighting."

For star use it is not easy to judge the centre of the bubble and the night lighting is preferred. Here the background is dark and the bubble is shown only by the presence of two red spots in a horizontal line. The star is placed between these for coincidence. The two spots are obtained by forming two images of a single lamp by means of two mirrors. The direct beam does not reach the collimating lens, but since the bubble acts as a negative lens, light is refracted by the bubble into the lens and a minute image of the lamp is seen in the bubble. Fig. 2 illustrates the principle, although only one of the beams is shown in the diagram.

Altitude Control

To obtain coincidence between bubble and star it is necessary to rotate the main index prism. This is done in two stages:

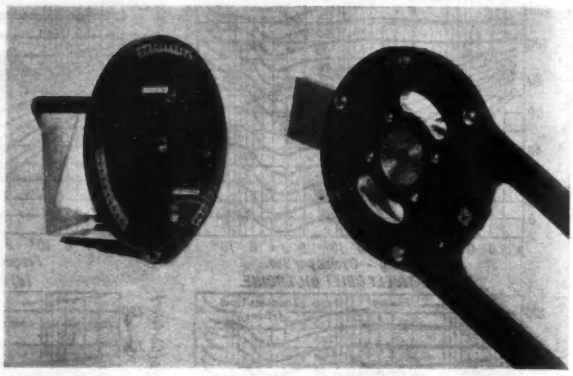


FIG. 3—INDEX PRISM AND HOLE PLATES

(*a*) In 10 deg. steps by use of a pin and hole plate.

(*b*) In fine adjustment by use of a lever and lead screw over 14 deg. to overlap the steps. With them it is possible to get elevations from −10 deg. to +90 deg.

Since the prism is likely to be at low temperature it was considered necessary to put the pin and hole plate at the top of the tube, to reduce temperature gradient errors, which entailed a small diameter for the plate and very accurate location of the holes. Fig. 3 shows the actual mounting, with the prism mounted on the plate containing thirty holes in three sets of ten each. Each hole is drilled around a 1¼in diameter pitch circle and is located to ¼ minute of arc. This corresponds to a location accuracy of 0·0015in for the average position of each set of three, but methods have been found to produce these plates to the required accuracy on a quantity production basis. The plate is retained on the three pins by light spring tension, but can be pushed away from the pins and rotated to another position by a double lever system

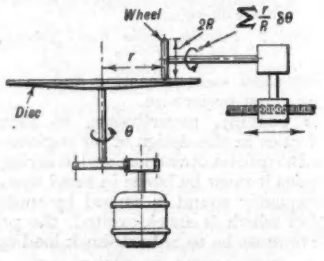


FIG. 4—SIMPLE INTEGRATOR

operated from the body of the sextant. Each hole can be calibrated and a correction listed for each 10 deg. setting.

The fine sighting adjustments are effected through a rocker bar control which actuates a reversible electric motor. Its drive connects with the prism through a screw acting on a long lever.

The Integrator

During a normal two-minute observation of a celestial body it is necessary to average out aircraft accelerations and vibrations and for this purpose the altitude drive is connected to a simple integrating mechanism based upon the

cone, ball and roller principle. Whilst readers may well be familiar with mechanical integrating principles (THE ENGINEER, July 19, 1935), some preliminary remarks upon them will help to illustrate the particular device as installed in the sextant. In Fig. 4 is shown the simplest possible arrangement of such a device employing a rotating disc, on which bears an edge wheel having its radii perpendicular to the disc

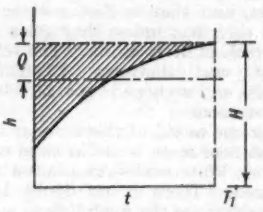


FIG. 5—HEIGHT-TIME FUNCTION

face and able to slide in a fixed radial direction with respect to the disc. Thus a rotation of the disc through an angle of $\delta\theta$ with the wheel at a distance r_1 from the centre of the disc will cause the wheel to rotate through an angle $\frac{r_1}{R}\delta\theta$.

Similarly with the wheel at any other radius r, separate displacements of the disc through an angle $\delta\theta$, will each give rise to further increments $\frac{r}{R}\delta\theta$. If it is assumed at this stage that there is no slip and that the radial motion of the wheel has no effect on its rotation then displacement of the wheel and rotation of the disc may occur simultaneously and the total rotation of the wheel will be given by $\sum\frac{r}{R}\delta\theta$.

Let now the radial displacement of the wheel and the rotation of the disc be effected by lead screws so that the wheel contact radius r is always proportional to the ordinate y of a particular function and the angular disc displacement proportional to the abscissa x. Then each increment $\frac{r}{R}\delta\theta$ will be proportional to $y\delta x$, since R is constant. Consequently the total rotation of the wheel will be proportional to $\int y dx$, i.e., the area of the curve traced by virtue of the two lead screws. In Fig. 5 is shown a curve of altitude h against time t and hence by arranging the disc rotation to be

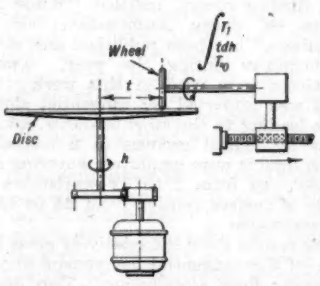


FIG. 6—SIMPLE INTEGRATOR FOR HEIGHT-TIME

proportional to time t and displacement of the wheel to altitude h the roller will record an area proportional to $\int hdt$.

The mean height of that diagram is given by $\frac{1}{T_1}\int_{t=o}^{t=T_1} hdt$, which will be proportional to the required mean altitude. However, to derive this quantity mechanically on the integrator it is necessary to arrange the drives in the reverse manner, as indicated in Fig. 6. Here it will be seen that the disc responds to altitude changes whilst wheel displacement is proportional to time. Hence the area recorded by the wheel is proportional to $\int_{t=o}^{t=T_1} tdh$, being that shaded in Fig. 5 and having a mean height

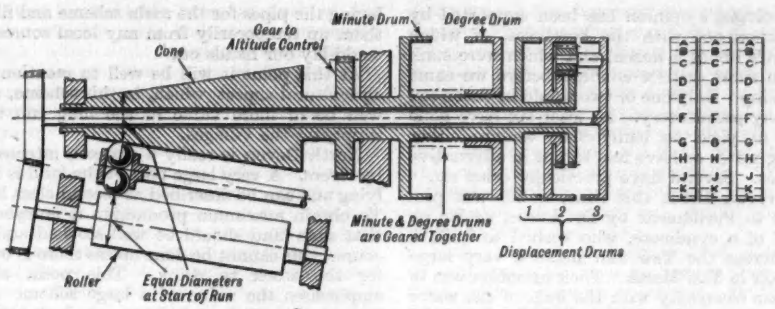


FIG. 7—DIAGRAMMATIC SKETCH OF INTEGRATOR

Q proportional to $\frac{1}{T_1}\int_{t=o}^{t=T_1} tdh$. The significance of this quantity is shown by integrating by parts the mean height $\frac{1}{T_1}\int_{t=o}^{t=T_1} hdt$ of the unshaded area in Fig. 5, which gives

$$\frac{1}{T_1}\left[HT_1 - \int_{t=o}^{t=T_1} tdh\right]$$

$$= H - \frac{1}{T_1}\int_{t=o}^{t=T_1} tdh,$$

where H is the altitude after T_1 secs. Thus the mean height is given by subtracting from the final reading the area registered by the wheel divided by the length of the diagram, an operation which can now be carried out mechanically. This operation, which is independent of time, is simply that of turning the disc until the wheel, held at its final disc radius, is restored to its original zero setting. The altitude then registered by the disc would have changed by an amount which must be represented by the mean height Q of the shaded area of the diagram in Fig. 5 and the disc thereby records directly the mean height of that diagram.

The assumption made earlier with respect to the combined rolling and sliding action is clearly not valid with the kinematic system described. Of several other arrangements embodying this kinematic principle, but which aim to employ a pure rolling action without sliding, is the one adopted in the sextant and shown diagrammatically in Fig. 7. In this mechanism a cone replaces the disc, rotation

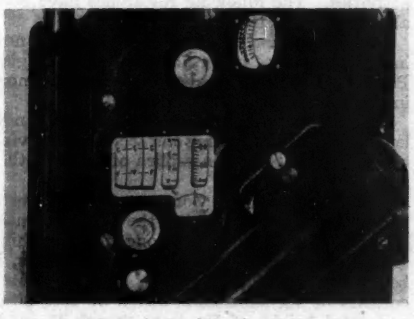


FIG. 8—ALTITUDE AND ALIGNMENT DRUMS

of which is communicated to a roller through two equal spheres, each rolling on the other. The cone is driven directly by the altitude drive motor and is suitably geared to the degree and minute indicator drums, the sphere cage being arranged to travel at constant speed between the cone and roller, the full traverse taking two minutes.

The initial gear ratio in this case cannot be zero as was implicit with the disc and edge wheel described. Consequently by choosing a ratio between cone and roller diameters at the start of a traverse equal to 1 it follows that the true distance the roller must be turned back to cancel the shaded area is that angular distance by which the roller and the cone have moved relative to one another. For this purpose the three alignment drums shown in Figs. 7 and 8, are employed, one (No. 1) being integral with the cone and another (No. 2) attached to a shaft running through the hollow cone member and driven through equal gears by the roller. These two drums are placed in alignment at the beginning of an observation and the process of cancelling the subsequent relative motion between them to obtain the mean altitude will be completed when both drums are again completely aligned with a common index letter, though not necessarily the original one. Aligning the drums in this way would be too critical an operation and the third drum (No. 2) is arranged merely to creep with respect to drum No. 1. It is driven through a sun pinion by an internal gear on the cone shaft, which has one more tooth than the corresponding wheel on itself. Thus, all three drums must be in alignment before and after an observation to assure the correct altitude is obtained. Drum No. 2 serves also to indicate in which direction to commence turning the cone for realignment purposes.

The complete mechanism has to be made with great precision and an adjustment is provided for parallelism between the adjacent surfaces of the cone and roller to prevent slipping due to loss of contact. The integrator is stated to be accurate to within a quarter-minute of arc.

The sole concessionaire of this instrument is Smiths Aircraft Instruments, Ltd.

Rural Water Supply in North Devon*

By MAJOR O. ALLHUSEN, C.B.E.†

THE difficulty of supplying water in rural areas is one of the oldest in the world. Moses got himself into trouble at Meribah and there has been trouble ever since. Queen Elizabeth made it possible to levy a parish rate for the parish pump and, although rural district councils were given powers at a much later date, it was not until Mr. Neville Chamberlain made it possible for county councils to contribute, under the Local Government Act, 1929, that there was any really effective attempt to tackle the problem in the majority of purely agricultural districts.

This now enabled the whole question to be tackled seriously, and we got down to business, a report being completed in 1934. The survey showed that in East Devon and South Devon local supplies were generally available, but in North Devon the position was pretty hopeless because such sources did not exist.

At this point we were fortunate in getting a geological report from the University College of the South-West which brought out the fact that, owing to impervious strata over a large part of North Devon there was little or no natural storage of water, and, in fact, satisfactory local supplies did not exist. We were, in fact, informed that if we wanted water in North Devon we would have to take it there, and, in practice, this meant from Dartmoor or Exmoor. Quite frankly, this gave us all a bit of a shock, because it obviously meant a very expensive undertaking.

At this point it might be well to mention that

*Abstracts, British Waterworks Association Winter Meeting, November 22nd.

†Chairman, North Devon Water Board.

the geologist's opinion has been supported by our experience with the boreholes, of which there are about a dozen, and which were sunk by the rural district councils before we came into being. Only one or two would be described as really satisfactory. At least six have gone down in yield so badly that we are either carting water or have had to put in alternative supplies. Several have practically dried up.

However, about this time, a bill was presented to Parliament by Dr. Purce, acting on behalf of a syndicate, who wished to build a dam across the Taw and make a very large reservoir in Taw Marsh. Their intention was to generate electricity with the bulk of the water and to lay a main to Barnstaple for industrial purposes, and this would be available to supply villages and farms *en route*. The bill was, however, rejected by the House of Lords.

The county council had entered a petition, in order to be heard, and in it we stated quite frankly that we knew the position in North Devon was very unsatisfactory and it was as a result of this that the Ministry, after the rejection of the bill, called on the county council to engage an engineer and get a report.

The county council then engaged as consultant Mr. S. R. Raffety, whose report made it quite clear that the only way to tackle the problem was to form a water board, consisting of the rural districts concerned and the county council. The water would have to be brought from Dartmoor, and this would necessitate many miles of pipes. By this time, however, the war clouds were looming and rearmament had started. The county council therefore marked time, but decisions on the main outline of the scheme were taken in the latter part of the war.

Two matters became obvious at a very early stage. First, that as water had to be brought very long distances, from Dartmoor and Exmoor, and had to be distributed in a large area lying between them, it was necessary that the board should cover a very large area. This is the reason that the area of the board is 1300 square miles, and is by far the largest purely rural area in England. We would have preferred a smaller area, which would have been more manageable if this had been possible.

Secondly, that there existed a very good water company, which, with its predecessor, had supplied Barnstaple and district for 250 years. The directors, with great public spirit, agreed at once that it would not be in the public interest that this island should continue to exist in the middle of the board's area, and they agreed to being taken over. This had been of the greatest help to the board, because it has been found possible to develop their source, which now serves villages outside the old water company's area.

The board's works fall into three parts. There will be three main sources of supply, namely, intakes from the West Okement and Taw rivers on Dartmoor, and an impounding reservoir at Wistlandpound in North Devon, which will be fed by the Yeo and additional sources. These will all meet at a central point near Torrington, and will be able to reinforce one another. It is proposed to lay 850 miles of pipes and there will be service reservoirs at suitable places. One of the best features of the whole scheme is that nearly the whole of our area will be supplied by gravity and pumping will only be necessary for a few high-lying places.

To-day we have practically completed the West Okement intake and treatment works. The pipe-line from there to Torrington, 26 miles away, is finished, and another pipe from Torrington to Rackenford, which runs right across the area for 36 miles is nearly finished, too. Another pipe from the West Okement to Tavistock is half finished, and in all we have laid about 120 miles of pipe. So far thirty-two villages have been supplied, and when the works under construction have been completed it will enable a further sixty villages to be served.

We have been forced, however, to put in several village schemes. Conditions in a good many of the villages and hamlets were so appalling that we could not let them wait for years. These have, however, all been constructed as far as possiole on the principle of laying the pipes for the main scheme and filling them up temporarily from any local source we could lay our hands on.

At this point it will be well to mention the agricultural aspect which, in this scheme, may well be of more value in the long run than supplying the villages.

North Devon is really a plateau, intersected by rivers. A very large part of the land is high lying and can be described as second-class land. To obtain maximum production it is essential that such land should be well stocked and, of course, this cannot be done unless there is water for the stock to drink. This point alone emphasises the value of a large scheme with high-pressure water which can reach the higher levels as opposed to small schemes which hardly ever can do this. Literally hundreds of farmers are anxious to produce T.T. milk, but cannot do so until they get a supply of clean water. They are signing up to take water in large numbers and, in fact, on the last line we surveyed, from Torrington to Westleigh, practically 100 per cent of the farmers within reach of the pipe indicated their intention to take water.

But, of course, the human problem is the one which comes first. We have 218 villages and over 400 hamlets in North Devon without a proper water supply. Four adjoining rural districts had not got one single public piped supply between them, and even if they had been able to finance any scheme they could not have got any water within reach because there are no satisfactory sources.

And lastly, finance. It is obvious that with such a very scattered population it is quite impossible to make two ends meet, or anything like it, and the question, speaking from a purely financial point of view, is whether it pays best to let these country districts go derelict and buy our food abroad, if we can scrape up enough foreign currency to do so, or, on the other hand, to put our hands in our pockets and put them on their feet. One thing is certain, and that is that nothing will put them on their feet unless they get a supply of water which is fit to drink. The scheme will probably cost between £3,000,000 and £4,000,000, and we hope to get £1,000,000 from the Government.

I think the moral of this story is that there is a great deal more to do in rural areas than the British Waterworks Association has really appreciated. There is no doubt that rural water supplies are the weak link in our armour and, while it is probably perfectly true that the water supplies of our cities and towns are the best in the world, this is not true of the countryside. From our experience every water authority must be large enough and financially strong enough to support a qualified water engineer to take charge. There is a school of thought which favours village supplies, but no one with any practical experience would support this. For one thing the cost of maintenance is very heavy, and experience has shown that local village supplies inevitably fail to meet growing demands, as they are usually incapable of expansion.

Research in the Motor Industry

THE sixth annual report of the Motor Industries Research Association for the year ended June 30, 1951, was published recently. Its opening remarks indicate certain difficulties in obtaining sufficient staff at the proving ground, but its usage during the last quarter was higher by 50 per cent than in any previous quarter. Satisfactory progress has been made with its new laboratories at Lindley, but this was unfortunately not so in the case of its other project, the high-speed test track and work on the site has still not commenced. Commenting on the Association's financial state, the report suggests that, due to devaluation of the pound, the expansion visualised some years ago will now be impossible without an increase in regular income. The report then indicates the extensive field of its research activities. The following researches have been abstracted from the report.

Proving Ground Development.—Work is now in progress on a further 750 yards of "Belgian Pavé," which has proved to be one of the more important test surfaces laid down.

It has also been decided to construct a new length of noise generating surface at the proving ground, which will be a replica of a "smooth" stone sett road.

In addition to the corrugated, or "washboard," track, which excites the unsprung mass systems of a vehicle, a "long-wave pitching track," designed to excite the sprung mass, is being constructed. To date a trial stretch consists of six sinusoidal waves of 40ft pitch and total height of 5in from trough to crest. One use of such a track is the study of shock-absorber characteristics and it is of interest to note that the behaviour of different cars, run at the same speed over this track, can be strikingly different.

Measurement of Noise in Vehicles.—The construction of a magnetic-tape noise recorder is now completed.

The main experimental work during the year has been concerned with three cars, all in the 1 to 1½ litre class, not only to evaluate the "noisiness" of the cars themselves, but also to investigate the correlation between objective measurements and subjective estimates of "noisiness."

The overall noise levels in these three cars are not greatly different from each other, only about 5 db. to 6 db. at the greatest, but the noise-spectra and speed analyses are markedly different in such ways as to agree with subjective estimates of the vehicles' relative noisiness. It cannot be doubted that the subjective differences between these three cars is a function not only of absolute noise level, but also of the character of the noise (i.e., its frequency distribution) and changes in intensity and character with speed.

The work suggests that detailed objective octave-band analyses are capable of correct subjective interpretation and define adequately the "noisiness" in a vehicle. A report on this work has been prepared.

Fuel Sprays for I.C. Engines (Extra-Mural).—A further report, entitled "Some Experiments on Spray Atomisation with Swirl Atomisers," has been published and circulated to members during the year. Two swirl atomisers were used in this work; in one, swirl was imparted by tangential slots in a plate leading to the swirl chamber, and in the other by helical grooves in a conical plug. Three liquids were employed, covering a range of viscosity from 2 to 32 centistokes and a range of surface tension from 24 to 73 dynes per centimetre.

The results show the relatively great importance of the tangential component of velocity in giving finer atomisation. Two disruptive effects are envisaged: the tangential component causes a stretching of the circumference of the jet, and, secondly, the kind of fluid motion prevailing in the orifice of a swirl atomiser gives rise to violent turbulence.

Of the physical properties of the liquid, viscosity is the one which most determines the degree of atomisation achieved, but its influence is to a surprising extent indirect. A spray of a more viscous liquid has a larger mean drop size and a much greater maximum drop size. In addition to its direct effect in resisting disruption of the liquid, increased viscosity reduces tangential velocity and, probably more important, damps down the turbulence in the issuing jet.

Surface tension of the liquid has little effect on atomisation from a centrifugal atomiser. At low injection velocities, raising the surface tension causes a slight reduction in the mean drop size, but at higher velocities the effect is rather to increase it. The size of the largest droplets in a spray increases with surface

tension, but here again the effect would be negligible for the comparatively narrow range of surface tension of most liquid fuels.

Factors hindering atomisation tend to increase the degree of non-uniformity of a spray and, for low velocities and high liquid viscosity, frequency curves with more than one maximum are obtained.

Other work under this heading concerns the effect of density and viscosity of the surrounding gas on spray atomisation and a study of energy losses in a swirl chamber atomiser.

Ventilation of Public Service Vehicles (Extra-Mural).—The system examined uses the forward motion of the vehicle to promote a generous flow of air through both passenger saloons, and waste engine heat is used to warm the air. Heated air is distributed at floor level and is diluted by varying quantities of unheated air—to suit changing climatic conditions—which is admitted at roof level in a way which prevents draughts.

Experience gained in twelve months' service shows a considerable improvement in passenger comfort. Incidental advantages are elimination of the main radiator, prevention of dust entry via the rear platform, effective demisting of windows and a reduction in deposition of dirt on internal surfaces.

Experimental Stress Analysis of Vehicle Structures.—A report entitled "The Experimental Determination of Static and Dynamic Stresses in a Double-Deck Public Service Vehicle" has now been circulated. The work was carried out on a London Transport Executive "RT3" double-deck public service vehicle.

The maximum total static stress measured in the frame due to the major components of the vehicle, and the passenger load of 8200 lb, was 3·5 tons per square inch compressive in the upper flange of the nearside channel member. Stresses in the body structure, while generally considerably lower, showed a maximum of 4·45 tons per square inch compressive in a vertical pillar just below the abutment of one of the hoopsticks carrying the upper saloon load.

Dynamic tests included bumping, cornering and braking tests; the bumping tests consisted of running over a 2in board at 20 m.p.h. with all four wheels and with the nearside wheels only, and the general stress level showed maximum initial stresses of 5 tons per square inch compressive in the chassis frame, and 4·25 tons per square inch compressive in the body structure, at the same points as in the static tests. Stresses due to bumping were approximately proportional to the height of the bump, but did not increase with speed above about 20 m.p.h. on the 2in bump. The frequency of stress signals from the chassis frame was 7·1 c/s; this appeared to be a natural frequency of the frame vibrating as a beam.

The maximum stress due to cornering was 6 tons per square inch tensile in the chassis frame, near the attachment of the rear stabiliser, and in the body an unusually high value of 7·9 tons per square inch compressive was reached in one of the transverse flitch beams by which the body is supported on the chassis.

The stresses due to braking were generally the lowest encountered, the maxima for chassis frame and body being 2·5 tons per square inch tensile in the upper flange of the side member and 2·2 tons per square inch tensile in the transverse flitch beam.

Experimental work in hand at the moment concerns the measurement of the working stresses in the structure of a small saloon car of "unitary" body chassis construction. As in other work of this nature, wire resistance strain gauges are being used, a large number of which are attached to give comprehensive plots of stress variation along and around members such as the longitudinal under frame box members, the body pillars, the door jambs and sills, and roof.

A torsional load of 2300 lb-ft was applied by removing the support from under one rear spring of the fully-laden vehicle.

The results show that the stresses due to this torsional load are generally considerably greater than those due to the direct load, and that the most highly stressed part of the structure is the lower end of the windscreen pillar, although high, but purely local, stresses exist in less important parts of the structure. Observed maximum stresses were 3400 lb per square inch tensile and 4600 lb per square inch compressive due to direct load, and 8000 lb per square inch tensile and 12,000 lb per square inch compressive due to torsional loading. True maximum tensile stresses occurring in the windscreen pillar are estimated to be considerably higher than those measured, for both direct and torsional loading occur on a spot-welded flange. There is evidence of high shear loads on these spot welds due to differential straining of the component pressings of the pillar.

The high stresses in the windscreen pillars are due to the relative flexibility of the underframe section below the front door opening, where stresses of 4000 lb per square inch were recorded. Flexure of the underframe under direct and torsional loads is restrained by the transmission of compressive and shear loads into the roof by bending loads in the windscreen pillars. Windscreen pillar stresses are therefore best reduced by stiffening the underframe in this region; excessive rigidity of the windscreen pillars will induce higher stresses while reducing those in the underframe, and very flexible pillars will reduce the overall rigidity of the vehicle and increase underframe stresses. In these parts of the structure the passenger load was found to give almost exactly double the stresses due to the vehicle structure weight, although the ratio of these two loads is only 1·2 : 1. The front passenger load alone is found to account for about half of the stresses in the windscreen pillar and about 60 per cent of the stresses in this section of the underframe.

The only other member in which the stress level was found to exceed 5000 lb per square inch was the central body pillar, at its upper end.

Experimental Determination of Stresses in Public Service Vehicle Wheels.—A report on the "static" stresses occurring in P.S.V. wheels was circulated to members early this year under the title "An Investigation of the Stresses in P.S.V. Type Wheels—First Report: Stresses Due to Static Loading."

The work covered three and four-piece wheels by several manufacturers, open and closed valve slots, the effect of offset and method of mounting, and the effect of different tyre sizes; the sizes of wheels used were 5·00 by 20, 6·00 by 20 and 7·33 by 20.

The highest stresses measured were at points corresponding to failures in service, namely, the fillet of the fixed flange of three-piece wheels, and in the gutter. Inflation stresses were substantially proportional to tyre pressure and load stresses were proportional to load up to the rated load of the tyre. On three-piece wheels the stresses decreased as the size of wheel increased, while for a given size the stresses were not significantly different for wheels by different manufacturers. For example, in 5·00, 6·00 and 7·33 wheels, by one manufacturer, the peak, steady and fluctuating stresses in the rim section at the fixed flange, due to combined inflation and axle load, with recommended tyres and tyre pressures, were 13·65 ±2·45, 8·30 ±1·90 and 6·2 ±1·75 tons per square inch respectively. Oversize tyres generally gave higher inflation stresses than the recommended tyres and at the rated loads gave load stresses approximately in proportion to these loads.

On four-piece wheels, load stresses were low, but inflation stresses both high and low were found, depending on the fit between the loose flange and retaining lip; on the data available, however, these wheels appear to be superior to the three-piece ones.

In the gutters, there was considerable variation of stress and this is attributed to high spots on the mating parts; the highest stresses were as high as those on the flange of three-piece wheels.

High compressive stresses were measured in the end of open valve slots, but they were reduced by more than one-half in the closed slots.

On the disc the inflation stresses were negligible and the load stresses small; if the disc were not flat, however, fairly high stresses occurred when the wheel was bolted to the hub.

Experimental work during the year covered by this report has been mainly concerned with the stresses set up by the dynamic loading the wheels experience in service on the road. Wire resistance strain gauges were used, with a slip-ring assembly, and M.I.R.A. four-channel dynamic strain recording equipment.

Stress distribution and relative magnitudes during straight running were similar to those obtained in the static tests.

With the test procedures used cornering stresses appear to be more serious than those due to either bumping or braking. On the rim cornering at 0·42 *g* true radial acceleration gave stress increases of 100 per cent on the front outside wheel, but less, namely, 55 per cent, on the rear. On the disc increases of several hundred per cent were found and the maximum stress range was 30 tons per square inch on the inside edge of the handhole with 1½ tons normal wheel load and a 5·375in offset wheel. At 0·5 *g* deceleration braking stresses on the rim were no more than those to be expected from load transference, i.e., there is negligible effect due to torque, while on the disc maximum stresses were about half those during cornering. On bumping, stress increases of about 100 per cent were measured on the rim and a maximum of 160 per cent on the disc, but each bump affects seriously only a small section of the wheel, whereas cornering subjects the wheel to several complete cycles of high stress.

The maximum disc stresses were not affected by either cutting the valve slot bridge of the disc or rim, but a change of offset from 5·375in to 4in reduced the maximum stress by 42 per cent.

A report on this work is in preparation at the time of writing and its issue will complete the programme of work originally envisaged on this item.

Bending Fatigue and Surface Fatigue Strength of Gear Teeth.—During the past year the work on surface fatigue strength of gear teeth, i.e., pitting, on gears, has been completed.

The results confirm that pitting is a form of surface fatigue failure, the life varying in an inverse manner with the stress applied, but over the range of life covered, i.e., 10^5 to 10^7 cycles, the "S-N" curves gave no indication of the presence of a fatigue limit below which failure would not occur.

The resistance to pitting appeared to depend upon the surface hardness of the materials, the three case-hardened steels having a load-carrying capacity of about 70 per cent higher, for any given life, than the three through-hardened steels; the nitrided steels showed a still greater resistance to pitting at all except the highest applied loads.

The use of lead in En. 24 through-hardened steel, to improve machinability, gave no reduction in pitting strength, but in En. 39A case-hardened steel caused a reduction of about 10 per cent in the load-carrying capacity.

Of the investigation into the effects on tooth fatigue strength, of methods of manufacture, so far, only one gear in each of four machining processes has been tested, namely, (*a*) finish hobbing, (*b*) rough protuberance hobbing, finished by shaving, (*c*) finish shaping, and (*d*) rough shaping, followed by formed-wheel grinding. From these few results the biggest difference is between the rough-hobbed and shaved gears and the finish-hobbed gear, the latter being about 20 per cent stronger in terms of applied bending moment. However, on a stress basis the difference is only about 10 per cent; this is because the rough-hobbed (protuberance) and shaved gears have more material removed from the tooth roots than the finished-hobbed gears.

Brake Fade.—Brake fade can be defined as the loss of braking efficiency due to operation at high temperatures, and delayed fade as the much greater loss after resting brakes for a period following operation at high temperatures. The term "high temperature" is necessarily vague, but, taking the mean temperature of the drum as the reference temperature, most linings begin to fade at some temperature between 200 deg. and 300 deg. Cent.

It has been found that very useful information on fade can be obtained by subjecting the lining specimen to a temperature cycle in which the drum temperature is raised uniformly to about 350 deg. Cent., at constant speed and load, and then decreased steadily. In road tests, made to correlate with the laboratory results, the linings are subjected to a similar, but necessarily more erratic cycle—since brake drum temperature cannot be controlled at will—by repeated braking. Correlation between laboratory and road tests is reasonably good, the degree of delayed fade being very marked in both cases during the "temperature decreasing" part of the cycle, decelerations of one-tenth normal being observed on the road. It is believed that this is the first time that attention has been drawn to this catastrophic fall in coefficient of friction on cooling after heating.

There is good circumstantial evidence for believing that "normal" fade and delayed fade are the result of certain constituents of the linings liquefying on heating to give a film of "lubricant" between the lining and the drum. To test this, linings have been "baked," before use, at 300 deg. Cent. for some thirty minutes, when there is a weight loss of some 4 to 8 per cent; such linings show no fade, up to 350 deg. Cent., either in the laboratory or on the road.

Brake Squeal.—Laboratory equipment and instrumentation for this work is now almost completed. With the particular braking system being investigated at present it is the brake drum which is the main (and probable only) source of "squeal." By exciting the drum magnetically, resonances, with emission of sound waves at the same frequency, are found well above 10 kc/s which sound very like brake squeal. Also, it has been found that there are fluctuations in braking torque identical in frequency with the brake squeal note.

Four-Stage Portable Air Compressor

A NEW portable air compressor now being made by the Consolidated Pneumatic Tool Company, Ltd., 232, Dawes Road, London, S.W.6, is built to supply air at pressures between 1000 lb and 2000 lb per square inch. This machine, which is illustrated above, has an air displacement of 197 cubic feet per minute.

The new compressor is driven through a multi-plate clutch by a Ruston and Hornsby five-cylinder, 125 b.h.p. oil engine. It is a vertical, single-acting, multi-stage, air-cooled unit with four cylinders in line. In the first and second stages of compression trunk pistons are fitted and a crosshead construction is used in the third and fourth stages. The circular crossheads are fitted with airtight rings and are designed to isolate each of their compression chambers from the crankcase of the compressor. The enclosed chambers between the crossheads and the pistons are vented into the compressor intake. With a common stroke of 5½in the respective cylinder bores are 9¾in, 5½in, 3¼in, and 2¼in.

Large air filters are fitted at the intake of the machine and finned tube intercoolers fitted with fan cooling are designed to cool the air between stages to within 20 deg. Fah. of ambient temperature. The machine can be supplied for a variety of working pressures and the safety valve settings for a typical unit are as follows: first stage, 40 lb per square inch; second stage, 110 lb per square inch; third stage, 350 lb per square inch; and fourth stage, 1200 lb per square inch.

FOUR-STAGE PORTABLE AIR COMPRESSOR

The forced feed lubrication of the machine is supplied by a gear pump which feeds oil to the main bearings. The oil passes through ports drilled in the crankshaft to the big ends and up through the centres of the connecting-rods to the gudgeon pins. The first and second stage pistons and the third and fourth stage crossheads are lubricated by oil mist thrown off by the rotating parts. A two-feed plunger sight feed lubricator driven by a belt supplies oil at a preset rate to the third and fourth stage pistons.

The rigid fabricated steel section chassis carrying the engine and compressor units is mounted on four pneumatic-tyred wheels with spring suspension. The plant is enclosed by heavy removable steel shutters and a large tank of 25 gallons capacity is fitted.

Technical Reports

An Economical Design of Rigid Steel Frames for Multi-Storey Buildings. National Building Studies Research Paper No. 10. By R. H. Wood, Ph.D. London: H.M. Stationery Office. Price 3s. 6d.—The economy in steel that might be achieved by the use of multi-storey rigid steel frames has not hitherto been attained, largely owing to the lack of a design method that is simple and reasonably accurate. This report describes a method that is simple and rapid and sufficiently accurate to avoid overstressing without losing the economic advantages of the rigid frame over the pin-jointed frame. The simplicity of the method is achieved by selecting, after analysis of a large number of frames, the variables that are of major importance. The effects of these variables are embodied in a series of substitute frames that take the place of the real frames. An analysis of the substitute frames is provided in the form of a series of design charts. From these the designer can obtain the moments graphically without solving any equations. The report includes worked examples and describes a new method of dealing with wind loads.

French Engineering News

(From our French Correspondent)

Protests have been made against the reduction of credits for modernisation of the French Nord and Pas-de-Calais coal mines. It is pointed out that every ton of coal imported costs, in the form of expenses or subsidy, as much as would be needed to increase French production by 1 ton; by modernisation at the coal face and the sinking of new pits to replace those which are worked out, production could be increased to 30 or 31 million tons annually, compared with 27,559,839 tons in 1950. Work on several new pits has had to be suspended, modernisation being concentrated at collieries where more immediate results are expected. It is hoped, however, that by 1953, when the new coal washery at Chocques is installed, the Auchel group will have one of the most modern installations in the basin.

* * *

Monsieur Postel-Vinay, Director General of the French Union, recently spoke before the Société d'Encouragement pour l'Industrie Nationale about industrial developments. He mentioned the piecemeal fashion in which new countries are usually developed, and said that organised research was needed to study countries before embarking on development projects. In addition to encouraging industrialisation in the French Union, he said, it was equally important to encourage the modernisation of agricultural and afforestation.

* * *

At the Sté des Mines de Zellidja, Morocco, five new coke ovens have been installed at the Oued el Heimer foundry and ten others are under construction. The daily capacity of an oven is 12 tons.

Experiments on underground gasification are being held at the Djerrada coal mines, where gas is being produced by this method. The aim is to use the gas in a turbine, which will drive a generator. A 2000kW Rateau experimental turbine is being used. The production of synthetic products—butane, propane, greasing oils, &c., is also envisaged.

* * *

No electrical load shedding is expected to take place in France this winter. Only very large industrial consumers will have to restrict consumption in December and January, and even that is not certain. As a result of the recent abundant rainfall the hydro-electric reservoirs have been filled; the total capacity of these reservoirs has been increased from an equivalent of 1305 million kWh in 1950 to 1928 million kWh this year. Stocks at thermal power stations are now evaluated at 600,000 tons, or forty days' supply. Last year's record consumption of almost 115 million kWh daily has already been exceeded by a figure of 118·6 million kWh. Demand is expected to increase to 126 million kWh this winter, for the heaviest day.

* * *

The first phase of the plan for the modernisation of the gas industry, from 1948 to 1952, envisaged an increase of 50 per cent in consumption, and this development has almost been completed. The number of subscribers has increased by about 100,000 annually, and over sixty small gasworks have been replaced by modern installations; coke tonnage has increased by over 30 per cent compared with 1947, and the total gas sales have increased by over 40 per cent compared with 1938. Finally, the production of the modern plants has increased by about 1,500,000 cubic metres daily. Among the more important projects at present envisaged is the consumption in Paris of gas produced by the East coking plants. By 1953 it is thought that a gas feeder network of 330km will bring about one million cubic metres of gas to Paris daily.

Tariffs were adjusted from January 1, 1951, to cover the constant deficits, and Gaz de France received 9500 million francs new capital. Other measures which are to be applied will make 1951 a transition year, but it is thought that the period of systematic deficits has passed. Gaz de France is now ready to abolish the financial aid given to it by Electricité de France for the past five years.

Industrial and Labour Notes

Iron and Steel Production

The production of steel ingots and castings during November averaged 316,100 tons a week, and was therefore at an annual output rate of 16,437,000 tons, compared with an annual rate of 15,629,000 tons in October and 15,628,000 tons over the first nine months of the year. Last year, in November, steel production was running at an annual rate of 17,472,000 tons. Pig iron output in November averaged 196,000 tons a week, which represented an annual rate of 10,194,000 tons. A year ago the annual output rate for pig iron was 10,042,000 tons.

Changes in Wage Rates

Changes in the rates of wages which were reported to the Ministry of Labour as coming into operation during October resulted in an aggregate increase of about £526,000 in the weekly full-time wages of 1,707,000 workpeople. Among those included in the increases were workers in agriculture, the iron and steel industry and in certain sections of the road passenger transport industry.

In the iron and steel industry the increases resulted from sliding scale arrangements based on the index of retail prices. In road passenger transport the operating staffs of company-owned bus undertakings in Great Britain received increases, retrospective to the end of August, of 8s. a week for drivers and conductors, of 11s. for skilled maintenance mechanics, and of 7s. to 8s. a week for other workers in depots and garages. In London, tram, trolleybus, bus and coach drivers, conductors and depot staff received increases of 8s. 6d. a week, and tramway and trolleybus permanent way staff received 7s. a week. Those increases also were retrospective to the end of August. With the increases reported in October, the Ministry of Labour says that 10,126,000 workers received rises in pay during the first ten months of this year aggregating £4,537,400 a week. In the corresponding months of last year there was a net increase of £681,000 in the weekly full-time wages of 3,600,000 workers. At the end of October the index of rates of wages (June, 1947=100) stood at 122 for all workers. At the end of December last the index was 114 for all workers.

Rising Costs

In the course of his chairman's address at the annual meeting, in Birmingham on Wednesday, of Tube Investments, Ltd., Mr. Ivan A. R. Stedeford made some comments on the existing apathy to rising costs. He said that the events of the past year, with their trail of economic dislocation both at home and abroad, unhappily provided eloquent testimony to the need for international co-operation in the economic field. When the defence plans of the Western Powers took shape it was plain to see that the sudden rise in demand, unless regulated, would overwhelm markets and lead to shortages and greatly inflated prices. But co-operative action, Mr. Stedeford suggested, had followed the formula of too little and too late and never had the world's commodity markets been shaken by such damaging fluctuations as in the last eighteen months.

Here at home, Mr. Stedeford continued, it had been hoped before the Korean conflict that the relatively mild inflation prevailing would be finally absorbed by this country's growing productivity. Our recovery, however, backed by such slender resources, was not proof against the heavy onslaught from outside, and the consequent world inflation had brought deplorable consequences all round. It was important to realise, Mr. Stedeford asserted, that the familiar fiscal remedies against "too much money chasing too few goods" were not the right remedies against this new kind of inflation. The pressure now at work, which had been set off by external events, was a "cost inflation" caused by prices, wages and costs chasing each other up an alarming spiral and stimulated by basic wages and salaries being linked with the cost-of-living index without regard to production. Under those conditions, Mr. Stedeford suggested, mounting wages and salaries, instead of being a welcome sign of growing national prosperity, became a cold warning of a further possible fall in the value of the pound.

That mad career, Mr. Stedeford remarked, must be arrested; although battered about, as we had been, by one crisis after another, we seemed to have been overtaken by an apathy to the difficult circumstances which had come upon us. That, he thought, perhaps explained why so far it had not been possible to get from both sides of industry the great overall effort of mind, skill and brawn necessary for the greater output and the lower costs which in the present emergency were the first essentials. To achieve that, Mr. Stedeford said he believed a new approach to the whole question of incentives was needed, and that the simple truth should not be overlooked that few in this imperfect world would normally work harder, longer and better, or take the yoke of heavier responsibility unless it was effectively made worth their while. He thought also that every endeavour should be made to perfect the technique of measuring productivity so that an agreed and realistic yardstick could in time be developed.

Trade Disputes

During the month of October, there were 207 stoppages of work through industrial disputes in progress in the United Kingdom. Altogether they involved 29,100 workpeople and caused an aggregate loss of 111,000 working days. In the preceding month, 110,000 working days were lost by 35,100 workpeople in the 177 stoppages of work through disputes which were reported to the Ministry of Labour.

Of the October stoppages, 115 occurred in the coal mining industry and as a result of them 27,000 working days were lost by 12,900 workers. There were twenty-two stoppages in the shipbuilding industry, involving 4800 workers and causing an aggregate loss of 30,000 working days. These stoppages included a strike of shipwrights employed by various Clydeside firms, which arose from a dispute respecting a claim for an adjustment in the basis of payment. The stoppage lasted from October 1st until October 29th, when work was resumed to permit negotiations. There were also eleven stoppages of work in the engineering industries involving 1900 workpeople and causing an aggregate loss of 18,000 working days.

The Ministry of Labour says that in the first ten completed months of this year, there were 1511 stoppages of work through disputes, involving 335,400 workpeople and resulting in a loss of 1,557,000 working days. The figures for the comparable period of 1950 were 1165 stoppages in which 281,300 workpeople were involved and through which 1,291,000 working days were lost.

Trade Union Membership

Statistics collected and published by the Ministry of Labour show that the aggregate membership of trade unions in the United Kingdom at the end of last year was approximately 9,235,000, compared with 9,267,000 at the end of 1949. The number of male members at the end of last year was 7,565,000, which indicated a decrease of 0·5 per cent compared with the previous year, while female membership totalled 1,670,000, or an increase of 0·6 per cent over 1949. The 1950 total of 9,235,000 included 53,000 members in branches in the Irish Republic and 97,000 in other branches outside the United Kingdom. The Ministry of Labour says that these figures represent the aggregate memberships of individual unions, and that persons who are members of more than one union are counted more than once in the totals. The extent of such duplication is not known precisely, but it is believed to be relatively insignificant.

At the end of 1950 there were seventeen unions each with a membership of 100,000 or more and 133 unions each with a membership of less than 100. It is explained that although the tendency towards amalgamation has resulted in a progressive fall in the numbers of separate unions, there were still 400 unions with fewer than 1000 members each. Dealing with the industrial distribution of union membership, the Ministry's survey states that in the engineering, shipbuilding and metal trades group there were 1,648,380 members at the end of 1950, compared with 1,640,060 a year earlier.

Another point mentioned in the survey is that in 1892—the earliest year for which statistics are available—the total membership of trade unions was a little over 1,500,000. The total increased year by year, with few exceptions, until 1920, when it reached nearly 8,350,000. It then declined and in 1933 was just under 4,400,000. The figures began to rise again in 1934 and continued to do so until 1948, since when there has been relatively little change. The number of federations of trade unions at the end of 1950 was fifty-two, the same as at the end of 1949.

Redundancy in the Engineering Industries

Before the House of Commons adjourned for the Christmas Recess on Friday last, there was a debate on the subject of redundancy in the engineering and allied industries. The matter was raised by Mr. Maurice Edelman, who asked what the Government was doing to restrict the amount of redundancy now appearing and the amount of under-employment which, he said, was apparent throughout the whole range of the engineering industries.

In the course of a reply to points raised in the debate, Sir Peter Bennett, Parliamentary Secretary to the Ministry of Labour, said that the question was a marginal one; the amount of steel which had caused existing redundancy or under-employment was nothing of a catastrophic order. Last year, 16,500,000 tons of steel were produced, and this year the figure looked like being something round about 15,750,000 tons. Next year, by a slight rearrangement and with exports reduced, home supplies would be slightly higher. If, Sir Peter continued, there were a very big fall in steel production, there would be more trouble and difficulty, but he did not think, in view of the estimates made, that difficulty of a drastic nature was to be expected.

Sir Peter went on to say that the Minister of Labour was discussing with the National Joint Advisory Council the subject of control of engagement. The matter would be examined very closely, but nothing would be done outside the joint arrangement or without Parliament being informed. As to short-time working, Sir Peter said that figures which had been produced showed that there had been a drop in the number of short-time workers and that there was a slight increase in the number actually unemployed which was what one would expect with developing troubles and shortages. A certain number of people were being stood off and less short time was being worked at the moment as compared with the summer and autumn. But, of course, it varied from week to week. There was, however, increased work being put into the armament industries, and the difficulty in future would not be shortage of work, but shortage of labour as the defence programme developed.

Notes and Memoranda

Air and Water

LLOYD'S REGISTER WRECK RETURNS.—Lloyd's Register of Shipping has issued a statistical summary of merchant ships totally lost and broken up during 1950. The returns show that 225 ships of 263,991 gross tons were totally lost due to casualty, which included 221 steamers and motorships of 258,835 gross tons, and twenty-eight of the ships, representing 63,103 gross tons, belonged to Great Britain and Northern Ireland. Ships broken up through causes other than casualty totalled 410, of 937,206 gross tons, of which 399 ships of 913,898 tons were steamers and motorships and of these 115 ships of 293,833 gross tons were owned in Great Britain and Northern Ireland. The gross reduction in the world mercantile marine during the year from all causes amounted to 635 ships, having a gross tonnage of 1,201,197.

FIRE RISKS OF AIRCRAFT FUELLING.—The results of an investigation by the Joint Fire Research Organisation for the Ministry of Civil Aviation are now published in Fire Research Technical Paper No. 1, "The Fire Hazard of Fuelling Aircraft in the Open." The paper is published by the Stationery Office, price, by post, 1s. 1½d. A stationary aircraft may contain up to 12,000 gallons of highly inflammable fuel. There is, therefore, a potential fire risk, which can be considerable. This hazard is greatly increased when the filling caps of the tanks are removed during fuelling and this investigation is the first in which the fire danger present when civilian aircraft are fuelling has been considered. During fuelling the area in which an explosive mixture of petrol vapour and air will be present will depend on the temperature of the fuel, the state of the air above the fuel in the tank, the speed of filling and the external atmospheric conditions. The paper takes into consideration the additional danger from fuel tank vapour vents, liquid overflow pipes and chance leakage and spillage. Tables are given indicating the fire danger area for any given wind strength and rate of filling.

Miscellanea

INSTITUTION OF ENGINEERING DRAUGHTSMEN AND DESIGNERS.—It is announced that the 1951 general meeting of the Institution of Engineering Draughtsmen and Designers will be held at the Waldorf Hotel, Aldwych, London, W.C.2, on Tuesday, December 18th, at 6.45 p.m., with the president, Lord Westwood, in the chair. The presidential address will be on the subject of "Chartered Status for Engineering Designers." At the meeting the Founder Column Award will be made to this year's winner, Mr. L. Bruce Archer.

METHANE GAS FROM SEWAGE SLUDGE.—The Minister of Fuel and Power, Mr. Geoffrey Lloyd, was asked in Parliament last Monday how far the production of methane gas from sewage sludge, by certain local authorities, had proved to be an economic source of fuel and power. He replied that the process was economic at large sewage works, but not at small ones, and that investigation into the fermentation process was continuing. Mr. Lloyd said he understood that, at present, there was about 1,000,000,000 cubic feet of this methane gas produced, which was roughly equivalent to 23,000 tons of coal.

MODEL OF PYRMONT BOILER PLANT.—International Combustion, Ltd., of 19, Woburn Place, London, W.C.1, informs us that a ½in scale model of the high-pressure water-tube boiler plant, nearing completion at Pyrmont power station, Sydney, New South Wales, is now on exhibition at the company's offices. The Pyrmont plant is the largest high-pressure water-tube boiler plant in the Southern Hemisphere, incorporating boilers each having a capacity of 430,000 lb of steam per hour at a pressure of 1280 lb per square inch, and a steam temperature of 950 deg. Fah. After being displayed in the principal Australian cities, the model will be used for instructional purposes in the Commonwealth.

MOND NICKEL FELLOWSHIPS.—The Mond Nickel Fellowships Committee has announced the following awards for 1951:—Mr. J. Preston, to study, in Great Britain, the U.S.A. and Canada, specialised methods of production and fabrication of metals, with particular reference to powder metallurgical techniques; Mr. P. E. White, to study the metallurgy and detailed production technique of high-quality strip steels in the United Kingdom, Scandinavia, U.S.A. and Canada, with particular reference to hardened and tempered steel strip, stainless steels and silicon steels; and Mr. P. J. Hill, to study in the United Kingdom the application of research to the development of corrosion-resistant metals for use in the mechanical engineering industry.

VISIT OF B.E.A. LONDON DIVISION CONTROLLER TO AUSTRALIA.—We learn that Mr. J. N. Waite, Controller of the London Division of the British Electricity Authority is to visit Australia for the purpose of advising the Electricity Commission of New South Wales on the power stations which are being taken over by the Commission. Mr. Waite sails on the S.S. "Orcades" on December 19th, and is due to arrive in Sydney on January 21st, when his address will be c/o Electricity Commission of New South Wales, Kelvin House, 15, Castlereagh Street, Sydney, Australia.

STRUCTURAL STEEL DESIGN.—The British Constructional Steelwork Association, Artillery House, Artillery Row, London, S.W.1, has recently published its technical brochure No... 3. This work is entitled *The Application of the Plastic Theory to the Design of Mild Steel Beams and Rigid Frames*, the author being F. A. Partridge, M.I.C.E. Its purpose is to explain what happens when members are bent beyond the elastic range to failure, to show how failure loads can be estimated, and so to introduce the plastic theory, in its application to beams and portals, as the basis for "fully rigid" design.

AN ASBESTOS ROOFING MATERIAL.—We have recently received details of a new weatherproof roofing material, marketed under the trade name of "Nuralite," which is composed of bitumen and asbestos. This material becomes sufficiently flexible, when warmed with a blowlamp, to permit its adaptation to a desired shape, and a technique has been developed for "welding" it to give a waterproof joint. After cooling, the material recovers its rigidity. It is supplied in standard 8ft by 3ft sheets, each of which weighs approximately 12 lb. It is manufactured by Cellactite and British Uralite, Ltd., Higham, Kent.

CHRISTMAS LECTURES.—The Institution of Civil Engineers' Christmas lectures for boys will this year deal with the subject of oil. The first lecture will be on Friday, December 28th, and will be given by Dr. G. M. Lees; it is entitled "Exploring for Oil." On Monday, December 31st, Mr. A. C. Hartley will lecture on "Transporting Oil in Peace and War (Pluto)," and on Wednesday, January 2nd, Mr. S. W. Adey will give his lecture, entitled "Working of an Oil Refinery." All three lectures will be given at 3 p.m. on the dates specified, at the Institution of Civil Engineers. They are intended primarily for boys between the ages of thirteen and seventeen years.

CHILDREN'S CHRISTMAS LECTURE ON ELECTRICITY IN AVIATION.—The Institution of Electrical Engineers has arranged a Christmas lecture for older school children, in the lecture theatre of the Institution at 3 p.m. on Thursday, January 3rd, and on Friday, January 4th. The subject of the lecture is "Electricity in Civil Aviation," and it will be delivered by Captain Peter Bressey, a senior pilot of the British European Airways Corporation. His lecture will express the viewpoint of the pilot and will show, with the help of films, the part played by electrical services, including radio communication, navigational aids and recent developments in precision electronic and visual aids to approach.

THE STEEL SCRAP DRIVE.—It is announced that the Ministry of Supply, the steel industry and the scrap merchants have decided, in view of the gravity of the steel scrap situation, to intensify the scrap drive in 1952. Discussions have taken place between the Minister, officials of the scrap drive organisation of the iron and steel industry, and the president, chairman and members of the Management Committee of the National Federation of Scrap Iron, Steel and Metal Merchants. Ways and means are being investigated to make even more effective the wide scale drive which has been undertaken since the beginning of this year by the iron and steel industry in collaboration with the scrap merchants industry.

JUBILEE OF THE ANGULAR-HOLE DRILLING AND MANUFACTURING COMPANY, LTD.—To mark the completion of its fifty years as an industrial undertaking, the Angular-Hole Drilling and Manufacturing Company, Ltd., of Beeston, Notts, has issued an interesting little brochure outlining its history and activities. This company was formed in July, 1901, by the combination of the Square Drilling Machine Company, Ltd., and the Angular-Hole Machine Company, Ltd., for the main purpose of building and marketing a square and angular hole drilling machine. The company also made spanners and early in the century decided to produce machine made box-spanners, which were accurately drilled to fit nuts, to replace the forged and cast spanners used at that period. Since that time it has specialised in the production of accurately machined box and other standard and special spanners for many purposes.

Personal and Business

MR. C. B. V. NEILSON, M.I.E.E., A.F.R.Ae.S., has been appointed technical director of Electro-Hydraulics, Ltd., Warrington.

THE BRUSH ELECTRICAL ENGINEERING COMPANY, Ltd., has acquired an interest in the Diesel Equipment Company, Ltd., of Canada.

MR. W. W. FRANKLIN, M.I.Mech.E., chief engineer of Davy and United Engineering Company, Ltd., Sheffield, has been appointed a director of the company.

MR. G. F. TEMPLE has been appointed sales manager of Modern Wheel Drive, Ltd., Chesham, Bucks, and its associated company, Oil-Operated Gears and Transmissions, Ltd.

MR. J. GRIFFITH HALL, director and secretary of Westinghouse Brake and Signal Company, Ltd., has been appointed a director of Westinghouse Garrard Ticket Machines, Ltd.

THE ADMIRALTY announces that Dr. E. C. S. Megan, formerly Superintendent of Research in the Admiralty Signal and Radar Establishment, has been appointed Director of Physical Research.

MR. R. RINGHAM has been appointed chairman of the East Midlands Divisional Coal Board in succession to Sir Hubert Houldsworth, K.C., who became chairman of the National Coal Board on August 1st.

ARMSTRONG SIDDELEY MOTORS, Ltd., states that Colonel the Hon. Cyril Siddeley is relinquishing, on medical advice at the end of the year, his position as manager of the motor-car side of the business. He will continue as a director.

MESSRS. MERZ AND MCLELLAN state that they are taking into partnership on January 1st next: Mr. A. E. Powell, Mr. E. L. E. Wheatcroft, Mr. H. J. Beard, and Mr. W. H. Dixon, who have been members of the staff for a number of years. Mr. Powell will normally be at the office at Carliol House, Newcastle upon Tyne, Mr. Wheatcroft and Mr. Beard at Milburn, Esher, Surrey, and Mr. Dixon at 32, Victoria Street, Westminster, S.W.1.

THE HARLAND ENGINEERING COMPANY, Ltd., Alloa, states that Mr. C. A. Atchley, who has been associated with the company since its formation in 1903, is retiring from the position of managing director. He will retain his seat on the board. Mr. R. W. Weekes, sales director, has been appointed managing director, and Mr. K. W. Atchley will act as works director and chief of engineering. It is also announced that a wholly-owned subsidiary is being formed, under the title of Harland Drives, Ltd., to carry on the work of the sectional electric drive department. Mr. K. W. Atchley is chairman of the new company, Mr. F. H. Maddox managing director, and Mr. R. C. Mortimer technical director. Mr. C. A. Atchley will also serve on the board.

VICKERS-ARMSTRONGS, Ltd., and Metropolitan-Cammell Carriage and Wagon Company, Ltd., announce that they are reorganising their representation in South Africa, as from January 1, 1952. At present both companies are represented in South Africa by Vickers and Metropolitan Carriage (South Africa), Ltd., which will change its name to Vickers-Armstrongs South Africa (Pty.), Ltd., and concurrently a new company, Metropolitan-Cammell Carriage and Wagon Company, Africa (Pty.), Ltd., will be formed. Vickers-Armstrongs South Africa (Pty.), Ltd., will sell the products of Vickers-Armstrongs, Ltd., in the Union of South Africa and the Rhodesias, and will also represent Robert Boby, Ltd., Palmers Hebburn Company, Ltd., G. J. Worssam and Son, Ltd., and, for certain of its products, Ioco Ltd. All these are members of the Vickers group of companies and are wholly owned subsidiaries of Vickers, Ltd. The company will also represent British Clearing Machine Company, Ltd., an associated company of Vickers, Ltd. The directors will be Mr. D. W. Stanley (chairman and managing director), Mr. B. L. Blaine, Mr. W. H. Butler, Mr. J. A. Killick, and Mr. A. H. Hird (resident in England). Metropolitan-Cammell Carriage and Wagon Company, Africa (Pty.), Ltd., will take over the representation in Africa of the interests of Metropolitan-Cammell Carriage and Wagon Company, Ltd., and will also represent in the territory Gresham and Craven, Ltd., Laycock Engineering Company, Ltd., George Spencer Moulton and Co., Ltd., Vacuum Brake Company, Ltd., and Maley and Taunton, Ltd. The directors will be Mr. D. W. Stanley (chairman), Sir Archibald J. Boyd (resident in England), Mr. F. O. G. Long (managing director), and Mr. W. A. J. Day. The offices of both companies will continue to be in Maritime House, Loveday Street, Johannesburg.

British Patent Specifications

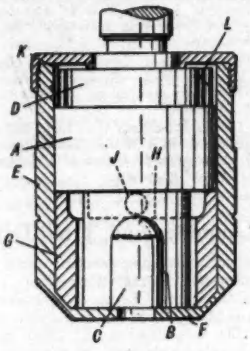
When an invention is communicated from abroad the name and address of the communicator are printed in italics. When an abridgment is not illustrated the specification is without drawings. The date first given is the date of application; the second date, at the end of the abridgment, is the date of publication of the complete specification.

Copies of specifications may be obtained at the Patent Office Sales Branch, 15, Southampton Buildings, Chancery Lane, W.C.2, 2s. each.

WORKSHOP TOOLS AND APPLIANCES

659,931. April 5, 1949.—CHUCKS, Arthur Waring, of Shakespeare Street, Birmingham, 11.

The inner member of the chuck comprises a cylindrical body portion *A* having a depending portion of reduced diameter in which radial grooves *B* to form a cage for the gripping rollers *C*. The upper portion *D* of the body is of reduced diameter. The outer member *E* is open at the top and the bottom is closed by an end wall *F* having a hole for receiving the shank of the drill. The cam ring *G* is a press fit in the sleeve and the inner end has a notch or recess *H* to form shoulders which co-act with a stop stud *J* screwed into the roller cage to limit the relative rotary movement of the inner member and the sleeve. The reduced cylindrical portion *D* at the top of the body forms an annular recess *K* at the top of the sleeve for receiving a spiral spring *L* which is coiled from a flat steel strip. One end of the spring is slid into a vertical groove or slit in the inner body and the other end engaged in a vertical groove or slit in the top of the sleeve. The body is retained in the sleeve against axial movement by a screwed cap. The top of the body has a tapered hole for engaging the shank of the drilling machine spindle. The drill is gripped by the rollers which are normally forced inwards into the gripping position by the spiral spring which turns the inner member to cause the rollers to ride up the cam faces. When the chuck is rotating and the sleeve is gripped it produces relative rotary movement of the sleeve in relation to the body, and thus releases the grip on the drill.—*October* 31, 1951.

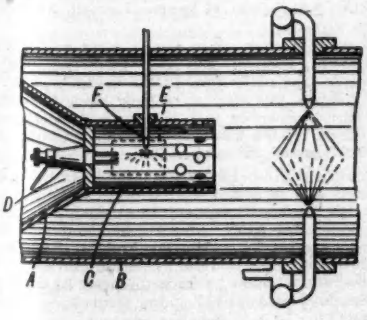


No. 659,931

GAS TURBINES

659,859. September 14, 1944.—BURNING FUEL IN A FAST-MOVING GAS STREAM, Power Jets (Research and Development), Ltd., 25, Green Street, London, W.1. (*Inventors: Henry Cohen and John Henry Hamilton Darth.*)

The invention is designed to provide means for maintaining complete combustion of the fuel injected into the gas or air stream without being subject to ignition troubles or blowbacks. The drawing represents a gas turbine jet propulsion system in which *A* is the rear portion of the fairing or bullet which is generally arranged in the jet pipe *B*. In order to raise the energy level of the exhaust gases additional fuel termed "reheat" fuel is injected into the jet pipe. For this purpose a small pilot combustion chamber *C* is fitted axially in the exhaust duct with its open end in the direction of flow of the gas stream. The forward closed end of the chamber is fitted with a sparking plug *D* surrounded by a perforated shield *E*; a pilot fuel jet *F* is fitted in the chamber a short distance to the rear of the plug whilst the end of the perforated chamber extends to a short distance upstream of a ring of main fuel burner nozzles. The fuel supply to the pilot jet may be from the main engine fuel pump or any other source. In operation, fuel injected into the chamber *C* within the shield *E* by the jet *F* vaporises in the chamber and is initially ignited by the sparking plug. A steady pilot flame then burns from the rear end of the chamber which acts as a shield for the pilot jet. The fuel injected by the main burner nozzles converges upon the pilot flame, to be ignited and maintained alight, so that combustion is completed in a short length and there is little appearance, if any, of a flame at the rear end of the jet pipe. Since the pilot flame issues from the rear end of the chamber and does not envelope the pilot jet, the jet does not become choked with carbon.—*October* 31, 1951.

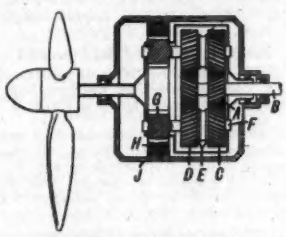


No. 659,859

POWER TRANSMISSION

660,430. June 13, 1949.—REDUCTION GEAR MECHANISM, Societe de Constructions et D'Equipements Mecaniques pour L'Aviation S.O.C.E.M.A., 60, rue de Londres, Paris.

The drawing shows an aircraft reducing gear. The sun gear wheel *A* comprises two separate sections rigidly connected and provided respectively with right-hand and left-hand helical teeth and is connected with a prime mover through the shaft *B*. The sun wheel meshes with one or several planet gear wheels, each of which consists of a pair of gear wheel halves *C* and *D* with right-hand and left-hand helical teeth. These gear wheel halves are adjustable axially with respect to each other by means of distance washers *E*, and a shoulder on their shaft *F*. The pair of gear wheel halves are assembled with eight resiliently mounted bolts designed to cushion vibration and also to secure, without play, resilient meshing of the teeth in this part of the reducing gear. Keyed on the shaft *F* that carries the planet gear wheel halves is a gear wheel *G*, the teeth of which mesh with those provided on the inside of a gear ring *H*. The gear wheel is adjustable axially with respect to the planet gear wheels and also adjustable angularly to some extent by modifying the distance between the gear wheel halves with the aid of the washers *E*. Such an adjustment becomes necessary notably where the reducing gear comprises a number of planet wheels, since it makes it possible to adjust each gear wheel angularly. The gear ring is fixed within a casing by resilient bolts *J* which cushion such vibration as may result from a lack of accuracy in the machining of the teeth and confer a limited flexibilty in the whole mechanism.—*November* 7, 1951.

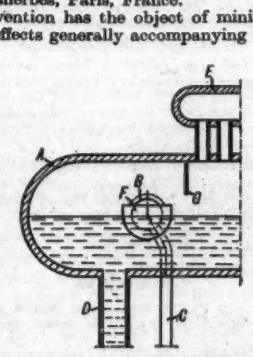


No. 660,430

STEAM GENERATORS

660,403. April 7, 1949.—STEAM GENERATING BOILERS, Societe Anonyme des Forges et Chantiers de la Mediterranee, of 25, Boulevard Malesherbes, Paris, France.

The invention has the object of minimising the harmful effects generally accompanying the formation of foam. In the drawing, *A* is the upper steam and water drum of a steam generating boiler, having a header *B* opening into it. Steam generating tubes *C* are connected with the header. *D* is a water downcomer tube, and *E* a steam collector. The invention essentially comprises a cup-like deflector element *F* in front of the mouth of the header *B* to direct any boiler foam or emulsion passing from it into the drum and compel it to discharge above the surface of the water in the drum. The element is provided with a single top outlet in a plane parallel with the normal water level in the boiler and slightly above that level, so as to prevent return flow of water into the header. An aperture of small diameter may be formed near the bottom of each element to ensure that a static balance obtains in the hydraulic system thus produced. Screens *G* of expanded metal or the like are preferably arranged to prevent direct entrainment of foam into the steam take-off or outlet or into the tubes leading to the steam collector.—*November* 7, 1951.

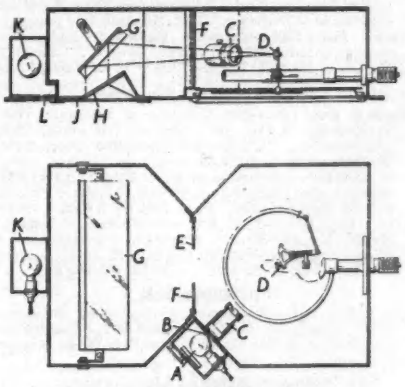


No. 660,403

INSTRUMENTS

661,484. March 10, 1949.—PRESSURE GAUGES, Hopkinsons Limited, Britannia Works, Huddersfield, Richard Leslie Brown and Jack Barker, both of the company's address.

This invention relates to pressure gauges of the Bourdon tube type, and its object is to provide an extended scale and a simple means for indicating a divergence from a predetermined range of pressures. As illustrated in the drawings, light from a lamp *A* fixed in a housing passes through an aperture *B* and is concentrated by a lens system *C* on to a small mirror *D* adjustably attached to an extension of the pinion shaft of a Bourdon tube gauge. The mirror reflects the light through an adjustable screen, which is coloured in part. When the beam is deflected beyond the normal working range it passes through a coloured part of the screen, a red part *E* when the pressure is too high or a blue part *F* when it is too low. The beam then falls on an adjustable mirror *G*, which deflects it on to a ground glass screen *H* set behind an opening in the case of the instrument, at an angle so as to avoid parallax with a scale *J* mounted behind the opening. The mirror is curved to cause the reflected light spot to travel in an arc on the screen. A pilot lamp *K* in series with the lamp *A* serves as an indicator that the pointer lamp is functioning and also illuminates an indicator *L* marking the correct pressure on the scale. With this arrangement an indication is obtained on an enlarged scale and a distinctive colour indication is given when the pressure is outside a given range, without any additional load being put on the gauge.—*November* 21, 1951.

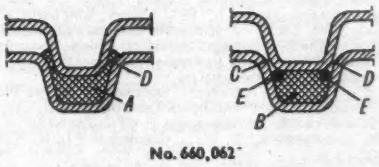


No. 661,484

HEAT EXCHANGERS

660,062. March 10, 1949.—PACKINGS FOR HEAT EXCHANGE PLATES, Aktiebolaget Separator, 8, Fleminggatan, Stockholm, Sweden.

The left-hand drawing shows a cross-sectional view of the packing grooves of two heat exchange plates with a packing positioned in the lower groove in the condition it assumes after some time of use, and the right-hand drawing shows the same grooves with a packing, made according to the invention, in the lower groove. As will be seen from the left-hand drawing, the material of the packing *A* has partly flowed out through the joints between the plates. To prevent the material from flowing out, the packing *B*, shown to the right immediately opposite the joints *C* and *D*, is provided with two wires *E* made of stainless steel.—*October* 31, 1951.



No. 660,062

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of their insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Association of Supervising Electrical Engineers

To-day, Dec. 14th.—BRISTOL BRANCH: Grand Hotel, Bristol, "Lighting—Theory and Practice," R. S. Hazell, 7.30 p.m.——CREWE BRANCH: Copeland Arms Hotel, Glebe Street, Stoke, "Television," R. U. Peters, 7.30 p.m.——NOTTINGHAM BRANCH: Electricity Showrooms, Smithy Row, Nottingham, "Motor Control Gear," P. C. Belton, 7.30 p.m.

Mon., Dec. 17th.—BOURNEMOUTH BRANCH: Grand Hotel, Firvale Road, Bournemouth, "Electronic Resistance Heating," T. S. Stanley, 8.15 p.m.

Wed., Dec. 19th.—MANCHESTER BRANCH: Engineers' Club, Albert Square, Manchester, "Chairman's Night," 7.30 p.m.

Thurs., Dec. 20th.—LUTON BRANCH: George Hotel, Luton, "Maintenance of Factory Equipment," A. Carpenter, 8 p.m.

Illuminating Engineering Society

Wed., Dec. 19th.—TEES-SIDE GROUP: Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough, "Street Lighting," A. J. Ogle, 6.30 p.m.

Thurs., Dec. 20th.—GLOUCESTER AND CHELTENHAM CENTRE: Cadena Cafe, High Street, Cheltenham, "Light as an Aid to Crime Detection," C. H. Edlin, 6.15 p.m.

Incorporated Plant Engineers

Mon., Dec. 17th.—W. AND E. YORKSHIRE BRANCH: Castle Museum, York, "Museums: Their Work and Assistance to Industry," C. M. Mitchell, 7.30 p.m.

Tues., Dec. 18th.—GLASGOW BRANCH: Engineering Centre, 351, Sauchiehall Street, Glasgow, "Safety in the Use of Portable Electric Tools," J. L. Wood, 7 p.m.

Institute of British Foundrymen

To-day, Dec. 14th.—MIDDLESBROUGH BRANCH: Head Wrightson and Co., Ltd., Teesdale Ironworks, Thornaby-on-Tees. "Patternmaking—Some Present-Day Practices," B. Levy, 7.30 p.m.

Sat., Dec. 15th.—BRISTOL AND W. OF ENGLAND BRANCH: Grand Hotel, Broad Street, Bristol, "Runner Practice in a Jobbing Foundry," H. B. Farmer, 3 p.m.

Wed., Dec. 19th.—N.E. SCOTTISH SECTION: Imperial Hotel, Keptie Street, Arbroath, "Production of Castings for a Small Diesel Engine," H. J. M. Conacher and R. Leeks. 7.30 p.m.

Institute of Fuel

Tues., Dec. 18th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Gasification by the Moving-Burden Technique," J. W. R. Rayner, 5.30 p.m.

Institute of Industrial Administration

Tues., Dec. 18th.—LONDON CENTRE: Management House, 8, Hill Street, Berkeley Square, W.1, "Management in Practice," No. 4, "From Sickness to Health: A Study of Improvements in Industrial Relations," J. E. V. Tyzack, 7 p.m.

Institute of Navigation

Fri., Dec. 21st.—Royal Geographical Society, 1 Kensington Gore, London, S.W.7, "Meteorology and Navigation," P. G. Satow, 5 p.m.

Institute of Road Transport Engineers

To-day, Dec. 14th.—S. WALES GROUP: S. Wales Institute of Engineers, Park Place, Cardiff, "Vacuum and Air Brakes," S. H. Edge, 7 p.m.

Tues., Dec. 18th.—MIDLANDS CENTRE: Crown Inn, Broad Street, Birmingham, "Pistons, Rings and Cylinder Liners," G. W. Yarwood, 7.30 p.m.

Wed., Dec. 19th.—N.W. CENTRE: Victoria Hotel, Wigan, "Garage Equipment and Service Tools," R. M. Walker, 7 p.m.

Thurs., Dec. 20th.—N.E. CENTRE: Hotel Metropole, King Street, Leeds, "Rear Axles," R. H. Wilson, 7.30 p.m.

Institution of Civil Engineers

To-day, Dec. 14th.—YORKSHIRE ASSOCIATION: Royal Victoria Station Hotel, Sheffield, "The Rapid Calculation of the Plastic Collapse Load of a Framed Structure," B. G. Neal, 7 p.m.

Institution of Electrical Engineers

Mon., Dec. 17th.—RADIO SECTION: Savoy Place, London, W.C.2, "What Practical Benefits can Communication Engineers Expect from the Modern Information Theory?" E. C. Cherry, 5.30 p.m.

Tues., Dec. 18th.—S. MIDLAND CENTRE: Town Hall, Birmingham, Faraday Lecture, "Sound Recording: Home, Professional, Industrial and Scientific Applications," G. F. Dutton, 6 p.m.

Wed., Dec. 19th.—SUPPLY SECTION: Savoy Place, London, W.C.2, "Inhibited Transformer Oil," W. R. Stoker and C. N. Thompson; "The Stability of Oil in Transformers," P. W. L. Gossling and L. H. Welch, 5.30 p.m.

Institution of Engineering Inspection

Wed., Dec. 19th.—W. OF SCOTLAND BRANCH: Engineering Centre, 351, Sauchiehall Street, Glasgow, "Productivity" films, 7.30 p.m.

Institution of Engineers and Shipbuilders in Scotland

Tues., Dec. 18th.—39, Elmbank Crescent, Glasgow, "Skidding and the Slippery Road," C. G. Giles, 6.30 p.m.

Institution of Locomotive Engineers

Wed., Dec. 19th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Railway Wind Tunnel Work," D. W. Peacock, 5.30 p.m.

Institution of Mechanical Engineers

To-day, Dec. 14th.—Storey's Gate, St. James's Park, London, S.W.1, Discussion on "Hydraulic Control Valves," B. Cooke, and "Hydraulic Power Transmission," A. E. Bingham, 5.30 p.m.

Sat., Dec. 15th.—N.E. BRANCH, GRADUATES' SECTION: Visit to the Locomotive Works, British Railways, Darlington, 10 a.m.

Mon., Dec. 17th.—E. MIDLANDS BRANCH: E. Midlands Gas Board Demonstration Theatre, Parliament Street, Nottingham, "The Problem of Hydrogen in Steel," Dr. Lloyd, 6.30 p.m.——SCOTTISH A.D. CENTRE: Institution of Engineers and Shipbuilders, 39, Elmbank Crescent, Glasgow, "Independent Rear Suspension," Donald Bastow, 7.30 p.m.

Tues., Dec. 18th.—LUTON A.D. GRADUATES' SECTION: W. H. Allen, Sons and Co., Ltd., Bedford, Symposium on "Lubrication," speakers J. E. Gannon, "Anti-Friction Bearings"; W. J. Park, 'Vehicles," and E. F. Clarke, "Marine Auxiliaries," 7.15 p.m.

Wed., Dec. 19th.—COVENTRY A.D. GRADUATES' SECTION: Craven Arms Hotel, High Street, Coventry, Annual Debate, 7.30 p.m.

Thurs., Dec. 20th.—MIDLAND BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Joint Meeting with Birmingham A.D. Centre, Film, 6 p.m.

Institution of Mining and Metallurgy

Thurs., Dec. 20th.—Geological Society, Burlington House, Piccadilly, London, W.1, "Mining Policy in French Overseas Territories," F. Blondel, 5 p.m.

Institution of Production Engineers

Mon., Dec. 17th.—DERBY SECTION: Midland Hotel, Derby, "Recent Developments in the Economic Use of Materials," G. F. P. Fox, 7 p.m.——MANCHESTER SECTION: College of Technology, Sackville Street, Manchester, "Management Ethics," H. E. Roff, 7.15 p.m.

Wed., Dec. 19th.—LIVERPOOL SECTION: Exchange Hotel, Tithebarn Street, Liverpool, "Brains Trust," 7.15 p.m.

Thurs., Dec. 20th.—GLASGOW SECTION: Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank Crescent, Glasgow, "Legal Aspects in Industry," A. E. Armour, 7.30 p.m.

Institution of Structural Engineers

To-day, Dec. 14th.—WALES AND MONMOUTHSHIRE BRANCH: County Buildings, Colwyn Bay, "Piling with Particular Regard to Sea Defence Works," J. Owen Lake, 6 p.m.

Mon., Dec. 31st.—MIDLAND COUNTIES' BRANCH: James Watt Memorial Institute, Great Charles Street, Birmingham, Films, "Buildings of the South Bank Exhibition," "Prelude to Power: The Building of the Castelo Do Bode Dam, Lisbon," "H.M.S.O., Sighthill, Edinburgh," 7 p.m.

Junior Institution of Engineers

To-day, Dec. 14th.—Royal Society of Arts, John Adam Street, London, W.C.2, Presidential Address, F. R. Banks, "Enterprise in Engineering," 7.30 p.m.

Mon., Dec. 17th.—SHEFFIELD AND DISTRICT LOCAL SECTION: Co-operative Educational Centre, 201, Napier Street, Sheffield, 11, "Aluminium Alloys in General Engineering," M. H. Levie, 7.30 p.m.

Fri., Dec. 28th.—39, Victoria Street, London, S.W.1, "Hydro-Electric Power Developments," J. Foster Petree, 6.30 p.m.

Liverpool Metallurgical Society

To-day, Dec. 14th.—Electricity Service Centre, Whitechapel, Liverpool, "Metallic Coatings," D. L. Phillips, 7 p.m.

Manchester Statistical Society

To-day, Dec. 14th.—Albert Hall, Manchester, "Statistical Tests in the Comparison of Laboratories," D. H. Ward, 6.45 p.m.

North-East Coast Institution of Engineers and Shipbuilders

Mon., Dec. 17th.—Mining Institute, Newcastle upon Tyne, "Marine Propulsion Miscellany," E. V. Teller, 6.15 p.m.

Royal Aeronautical Society

Thurs., Dec. 20th.—Institution of Mechanical Engineers, Storey's Gate, St. James's Park, S.W.1, "Control Surface Flutter," E. G. Broadbent, 6 p.m.

Royal Meteorological Society

Wed., Dec. 19th.—49, Cromwell Road, London, S.W.7, "The Warming of Arctic Air Masses Over the Eastern North Atlantic," J. M. Craddock: "The Modification of Continental Polar Air Over Hudson Bay," F. E. Burbridge: "Observations with a Directional Rain Gauge," R. E. Lacy, 5 p.m.

Sheffield Society of Engineers and Metallurgists

Mon., Dec. 17th.—The University Building, St. George's Square, Sheffield, "A Rational Theory of the Hardening of Steel," A. H. Marks, 7.30 p.m.

Catalogues

FIELDING AND PLATT, Ltd., Atlas Works, Gloucester.—Brochure describing hydraulic scrap metal baling presses.

METRONIC INSTRUMENT COMPANY, Ltd., Ettingshall, Wolverhampton.—Booklet explaining how to read the cupola meter.

KEITH BLACKMAN, Ltd., Mill Mead Road, Tottenham, London, N.17.—Brochure describing "Tornado" man cooling fans.

RHEOSTATIC COMPANY, Ltd., Slough, Bucks.—List No. 140, illustrating and describing the "Satchwell" range of modulating valves.

TRIEFUS AND CO., Ltd., St. Andrews House, 32, Holborn Viaduct, London, E.C.1.—Booklet illustrating a range of diamond tools.

UNITHERM, Ltd., 19, Chatsworld Road, Hayes, Middlesex.—Leaflet describing the "Unitherm" system of automatic combustion control.

RAINSFORD AND LYNES, Ltd., Emily Street, Birmingham, 12.—Leaflet describing the "Bullfinch" self-blowing torch for use with bottled gas.

R. A. LISTER (MARINE SALES), Ltd., Dursley, Gloucestershire.—Catalogue dealing with the Blackstone range of marine diesel engines types EVM and EVSM.

AVIATION DEVELOPMENTS, Ltd., Kingsbourne House, 229–231, High Holborn, London, W.C.1.—Folder describing the "Chobert" system of blind riveting.

STURTEVANT ENGINEERING CO., Ltd., Southern House, Cannon Street, London, E.C.4.—Publication No. 6505, entitled "Pneumatic Dust Collecting and Conveying."

SIR W. G. ARMSTRONG WHITWORTH AND CO. (IRONFOUNDERS), Ltd., Close Works, Gateshead-on-Tyne, 8.—Brochure for use as a work of reference in rolling mills.

ATLAS DIESEL COMPANY, Ltd., Beresford Avenue, Stonebridge Park, Wembley, Middlesex.—Catalogue illustrating pneumatic hand tools, for rotary files and cutters.

NORMAND ELECTRICAL COMPANY, Ltd., North Street, Clapham Common, London, S.W.4.—Catalogue No. 518, illustrating and describing standard "Neco" motors and geared motors.

DAWE INSTRUMENTS, Ltd., 130, Uxbridge Road, Hanwell, London, W.7.—Brochure summarising the range of electronic equipment manufactured by the Instrument Division.

THOMAS DE LA RUE AND CO., Ltd., Imperial House, Regent Street, London, W.1.—Handbook giving guidance on the most suitable grades of Delaron Laminated Plastic for various purposes.

Launches and Trial Trips

FRAGUM, bulk bitumen carrier; built by Smith's Dock Company, Ltd., for the Anglo-Saxon Petroleum Company, Ltd.; length between perpendiculars 315ft, breadth moulded 46ft, depth moulded 19ft 6in, deadweight 3350 tons on 17ft draught; single triple-expansion steam reciprocating engine, cylinders 18½in, 31in and 53in by 30in stroke, taking steam from two single-ended, multitubular boilers, 1600 i.h.p. at 135 r.p.m. Launch, November 28th.

R.F.A. EDDYBAY, Fleet auxiliary; built by the Caledon Shipbuilding and Engineering Company, Ltd., for the Naval Stores Department, Admiralty; length overall 286ft, breadth moulded 44ft, depth moulded 18ft 6in, deadweight 2095 tons, draught 17ft 2in; enclosed triple-expansion steam engine, by Lobnitz and Co., Ltd., 1750 i.h.p. at 227 r.p.m., two cylindrical boilers, speed 12 knots. Launch, November 29th.

EBRO, cargo ship; built by Harland and Wolff, Ltd., for the Royal Mail Lines, Ltd.; length between perpendiculars 415ft, breadth moulded 58ft 6in, depth moulded to shelter deck 38ft 4in; Harland-Burmeister and Wain two-stroke, single-acting, opposed-piston eccentric oil engine, six cylinders, 620mm diameter by 1870mm combined stroke, 115 r.p.m. Launch, November 29th.

SUHAIL, motor tanker; built by the Furness Shipbuilding Company, Ltd., for the Afran Transport Company, Liberia; length between perpendiculars 560ft, breadth moulded 80ft, depth moulded 42ft 3in, deadweight 24,400 tons on 32ft 3½in draught; Hawthorn-Doxford single-acting, two-stroke oil engine, six cylinders, 670mm diameter by 2320mm combined stroke, b.h.p. 6600 at 115 r.p.m., speed 14 knots. Launch, November 29th.

KING MALCOLM, cargo liner; built by Harland and Wolff, Ltd., for the King Line, Ltd.; length between perpendiculars 435ft, breadth moulded 59ft, depth moulded to shelter deck 39ft 9in; Harland-Burmeister and Wain diesel engine, six cylinders, 740mm diameter by 1500mm stroke, 115 r.p.m. Launch, November 29th.

SCOTTISH LION, motor tanker; built by Swan, Hunter and Wigham Richardson, Ltd., for the Scottish Tanker Company, Ltd.; length between perpendiculars 515ft, breadth moulded 69ft 6in, depth moulded 38ft 4½in, deadweight 16,250 tons on 30ft draught; Wallsend-Doxford two-stroke oil engine, six cylinders, 670mm diameter by 2320mm stroke, 6400 b.h.p. at 115 r.p.m. Launch, November 30th.

COPSEWOOD, cargo ship; built by the Burntisland Shipbuilding Company, Ltd., for the Constantine Shipping Company, Ltd.; length between perpendiculars 214ft 6in, breadth moulded 35ft 4in, depth moulded 16ft, deadweight 1675 tons, draught 15ft 8½in, three cargo holds, electrical deck machinery; British Polar two-cycle, trunk-piston, airless-injection diesel engine, four cylinders, 340mm diameter by 570mm stroke, 640 b.h.p. at 250 r.p.m. Trial, November 30th.